

Concrete

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Codes of Ethics

A FINE motto hanging over a man's desk will not save him for success, usefulness or respectability. It is so too with codes of ethics. A code of ethics makes a good first impression like a Chesterfieldian manner. But daily conduct that springs from sound logic and good impulses has better wearing quality. There is much in print nowadays about codes of ethics. Business and trade organizations find it useful in selling themselves to the public to subscribe to new decalogues of high purpose; all of which is a good sign but not a guarantee. Let us take codes of ethics seriously—they have big educational value. Let's not take them too seriously because lip service never made good concrete nor carried out the letter and spirit of any set of specifications.

A code of ethics is like a legal enactment—it doesn't raise human intelligence or the quality of moral fibre.

There has been from time to time a good deal of complaint about legislative and bureaucratic interference with the machinery of business. There has been Department of Justice interference with trade and commercial organizations, some of which got, justly or otherwise, into bad repute on suspicion of having forgotten that business is for public service and that its just rewards are in proportion to the service given.

Secretary Hoover has labored ceaselessly to evoke in these organizations their potential power for public good. Men in a given line of work can regulate themselves if they have the will to do it, with better public results than when Congress regulates them.

There are so many ways to evade mere laws, as we in America have learned, that laws are only about as good as the moral support the public gives them. A code of ethics is just as good too as the sober convictions of the men who adopt it—and not one bit better.

The value of a code of ethics is wholly dependent on the progressive education of the individuals of an organization who adopt such a code. If some people subscribe to a code of ethics with the same calculating acquisitiveness with which they join a church, a lodge or a political organization, because it supplies them with a respectable masquerade, and the effulgence of reflected glow—then the code of ethics so far as these are concerned, is a scrap of paper.

The really encouraging thing is that the quality of our business convictions is improving. Our horse-trading instincts are changing. Without assuming any role of preacheresqueness it is true that "honesty is the best policy." Beating the specifications does not pay in dollars and cents.

All of which is by way of directing attention to the "Principles of Business Conduct" adopted by the Chamber of Commerce of the United States on which the Associated General Contractors is laying proper stress in its literature and on which Judge Edwin B. Parker makes this comment:

It will be noted that all of the principles of business conduct have their source in motives of ultimate enlightened self-interest. They do not spring in whole or in part, from the emotionalism or the altruism of the social dreamer who dimly glimpses a distant vision but points us to no road whereby to reach it. Yet when the objective sought is closely examined, it bears a striking likeness to the vision of the dreamer. By different routes the same end is reached.

The "principles" are as follows:

THE FUNCTION OF BUSINESS is to provide for the material needs of mankind, and to increase the wealth of the world and the value and happiness of life. In order to perform its function it must offer a sufficient opportunity for gain to compensate individuals who assume its risks, but the motives which lead individuals to engage in business are not to be confused with the function of business itself. When business enterprise is successfully carried on with constant and efficient endeavor to reduce the costs of production and distribution, to improve the quality of its products, and to give fair treatment to customers, capital, management, and labor, it renders public service of the highest value.

We believe the expression of principles drawn from these fundamental truths will furnish practical guides for the conduct of business as a whole and for each individual enterprise.

1—THE FOUNDATION of business is confidence, which springs from integrity, fair dealing, efficient service, and mutual benefit.

2—THE REWARD of business for service rendered is a fair profit plus a safe reserve, commensurate with risks involved and foresight exercised.

3—EQUITABLE CONSIDERATION is due in business alike to capital, management, employees, and the public.

4—KNOWLEDGE—thorough and specific—and unceasing study of the facts and forces affecting a business enterprise are essential to a lasting individual success and to efficient service to the public.

5—PERMANENCY and continuity of service are basic aims of business, that knowledge gained may be fully utilized, confidence established and efficiency increased.

6—OBLIGATIONS to itself and society prompt business unceasingly to strive toward continuity of operation, bettering conditions of employment, and increasing the efficiency and opportunities of individual employees.

7—CONTRACTS and undertakings, written or oral, are to be performed in letter and in spirit. Changed conditions do not justify their cancellation without mutual consent.

8—REPRESENTATION of goods and services should be truthfully made and scrupulously fulfilled.

9—WASTE in any form—of capital, labor, services, materials, or natural resources—is intolerable and constant effort will be made towards its elimination.

10—EXCESSES of every nature—inflation of credit, over-expansion, over-buying, over-stimulation of sales—which create artificial conditions and produce crises and depressions are condemned.

11—UNFAIR COMPETITION, embracing all acts characterized by bad faith, deception, fraud, or oppression, including commercial bribery, is wasteful, despicable, and a public wrong. Business will rely for its success on the excellence of its own service.

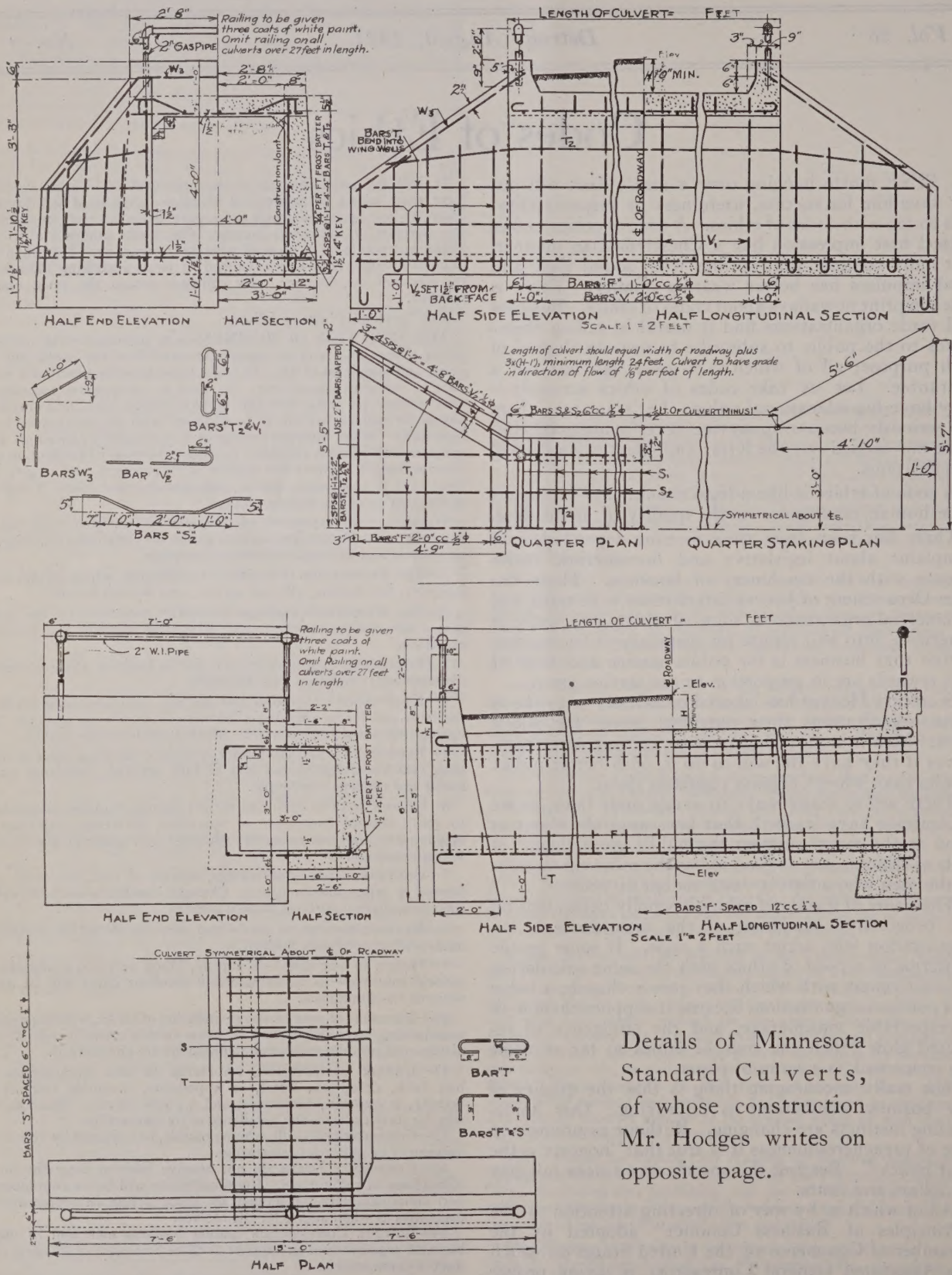
12—CONTROVERSIES will, where possible, be adjusted by voluntary agreement or impartial arbitration.

13—CORPORATE FORMS do not absolve from or alter the moral obligations of individuals. Responsibilities will be as courageously and conscientiously discharged by those acting in representative capacities as when acting for themselves.

14—LAWFUL COOPERATION among business men and in useful business organizations in support of these principles of business conduct is commended.

15—BUSINESS should render restrictive legislation unnecessary through so conducting itself as to deserve and inspire public confidence.

Getting a Good Culvert Job



Details of Minnesota Standard Culverts, of whose construction Mr. Hodges writes on opposite page.

Getting a Good Culvert Job: *Staking and Excavation, Building Forms, Placing Steel and Concrete, Finishing Surfaces, Removing Forms*

By W. R. HODGE

WHEN the author of this paper first became culvert inspector on trunk highway No. 35 in Minnesota, he was turned loose and told to "go out and inspect culverts" (about 100 in all along 25 miles of road between Virginia and Hibbing). Being a mining engineer with a good deal of experience with concrete he worked out an inspection technique, and when he left road work to go back to mining he wrote instructions for his successor. Since it points out the weak spots of culvert building oftenest encountered, it is a good paper for the contractor building culverts and the engineer inspecting their construction.—Editor.

The duties of culvert inspector include in a general way the supervision, under the resident engineer, of all operations in the construction of the culverts on his division, the passing or rejection of all materials used in the culverts, keeping adequate reports on the construction and, in some cases, the detailed instruction of the contractors in the elements of concrete construction. More specifically the inspector's duties are outlined in the following paragraphs.

On State Highway 35 two types of monolithic concrete culverts are used, the wingwall (W) and the face-wall (F). On the blueprints furnished the inspector they are designated (1) by the characteristic type of wall, (2) by the width of opening and (3) by the height of opening. A facewall culvert 3 ft. wide by 2 ft. high would be designated F32.

STAKING AND EXCAVATION

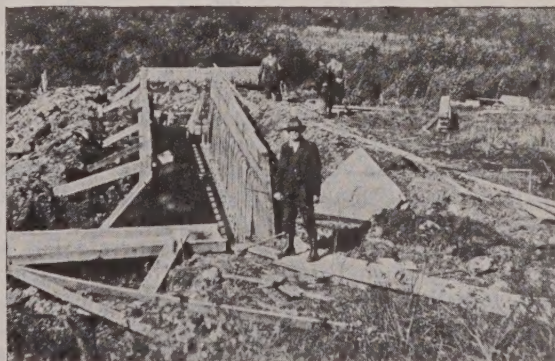
As a usual thing, culverts are staked out by the transitman on the right of way several weeks before the grading work is begun. Eight stakes are set. Four stakes are on the center line, one in the face of the culvert at each end and one at each end at a random distance out from the first stakes. Two stakes are set 15 ft. out on each side of the center line of the culvert and on a line with the face of the culvert at each end. On these last four stakes is marked the distance, usually even feet, from a nail in the side of the stake to grade. The grade indicated is that of the floor of the culvert, the surface on which the water flows. Allowance must be made in excavating the barrel of the culvert for an additional depth for the floor and in the end walls for the drop-wall or footing. Grades should be checked against those marked on

the stakes when the excavation is thought to be completed. Also the dimensions of the excavation should be checked. About one foot on all sides of the completed concrete is usually enough to allow for the placing and removal of forms, though this may be varied with the size of the culvert and the depth of the excavation. Diagrams of the actual completed excavation should be inserted in a culvert book, together with yardage excavated and classification of material as earth, loose rock (L. R.) or solid rock (S. R.). Loose rock is rock from the size of a man's head to two feet in diameter. Solid rock is all rock over that size.

Excavations must, where possible, be carried to a firm foundation material, red clay, sand, gravel or loose rock. If this takes the excavation below the grade of the bottom of the culvert floor, the excavation must be backfilled to the proper grade with suitable material. Or, if the excavation must be carried very deep to obtain good foundation, it will be necessary to float the culvert on a raft of timbers or support it on piles. This is a matter for the resident engineer to decide. If the excavation is in moderately soft ground, widening out and strengthening the base of the culvert may suffice to provide a safe bearing. The excavation, during the pouring and until the concrete has set, must be kept free from water. When the sides of the excavation show a tendency to slough the inspector should see that sufficient bracing and shoring is put in place to make the place safe to work in.

FORMS

All lumber used should be sized and planed on one face and two edges to secure uniform thickness and tight joints, necessary for a smooth finish to the concrete. The lumber should be fairly free from knots. Shiplap is not necessary.



"THIS MATTER OF BRACING AND STRENGTHENING FORMS I HAVE FOUND DIFFICULT TO BRING TO THE COMPREHENSION OF THE CONTRACTOR"

For all culverts the inside (core) form and face wall forms should be of 2 in. stock. In the smaller culverts 1 in. stock for the outside walls of the barrel and 2 in. x 4 in. studding will serve very well. But for all culverts 4 ft. x 4 ft. and larger heavier stock should be used—at least for studding. All forms should be crosswired together at top and bottom to keep them from spreading. And in addition they should be braced externally to the ground. When the culvert is built in a deep excavation this is easily done by blocking and wedging between the sides of the excavation and the forms. Spiking a long 2 x 4 to a peg driven in the ground does not constitute adequate bracing. The face walls must have a 2 in. x 4 in. or 2 in. x 6 in. piece set edgewise along the top of the form to secure correct alignment for the finished structure. Studding should not be set at greater than 3 ft. centers. This matter of bracing and strengthening forms I have found difficult to bring to the comprehension of the contractor. He does not seem to be able or willing to realize the pressure the wet concrete exerts against the forms.

All exposed corners are to be finished with a 45° bevel strip on the inside of the form, partly to facilitate removal and partly to prevent chipping the concrete when the forms are removed.

The forms must be tight. Small cracks will swell shut when the concrete is poured but large cracks, knotholes and poor joints must be covered with tarpaper or thin metal strips tacked to the inside of the forms. A leaky form will leave dry spots in the surface of the concrete and allow frost to enter and disintegrate the structure. Large cracks will be present in the forms when they have been built and allowed to lie unprotected from the sun for some time before using.

All forms must be cleaned of concrete immediately after being removed from the culvert. If the concrete is allowed to stick and the forms are used over again a rough spot will be produced in the subsequent work.

The inspector must check all dimensions when the forms are in place and make sure the forms are correctly placed and that the slope of the floor is in the right direction to produce the desired drainage.

REINFORCING

The steel reinforcing must be clean and free from mud, dried cement and rust and scale. The contractor must have wire brushes for cleaning reinforcing where necessary. It is not advisable to use smooth round iron for reinforcing.

The reinforcing for the bottom, sides and ends should be in place before the floor is poured. All steel is to be substantially wired together with haywire. A special tool is made by one manufacturer for twisting prepared wire loops about the reinforcing steel. This has proved very satisfactory. The bottom reinforcing steel should be securely wired to form a rigid grill. It is not necessary to wire every point where the reinforcing rods cross to obtain a rigid grill. The grill should be supported in place by rocks—not wooden blocks—set under the reinforcing on the ground. In the F22 culverts the vertical side rods may be omitted until the bottom is poured and then placed before the concrete has set, if care is taken to get them exactly in place and alignment before the concrete has set. However it is much better practice to wire them in place before the bottom is poured. All other sizes of concrete culverts should have the side reinforcement in place before pouring the bottom. Where splices are made in the longitudinal rods the splices should lap 30 in. or more and be wired firmly together. The reinforcing for the top must be placed before the side walls are poured and should be wired together and to place.



All reinforcing steel is to be mild and not high carbon steel.

Steel should be placed with the minimum of variation from the blueprint as to amount or position. This needs careful watching on the part of the inspector.

MATERIALS

Run-of-pit sand-gravel may be used if close enough to a 2:4 proportion and free from objectionable matter. However it is best to use crushed rock or washed gravel for the coarse aggregate, mixing them in the proportions required, with clean coarse sand for the fine aggregate. The coarse aggregate should be clean, free from clay coating or organic matter and should contain little or no slate. It should be of such size as would pass through a 1½ in. mesh screen and be caught on a ¾ in. mesh screen. For bottoms and endwalls 2 in. rock may be used but in the sidewalls these larger rocks catch between the reinforcing and the forms and make spaces in the walls which contain little or no concrete and force the rods out of position. It is desirable to have a mixture of graduated sizes in the coarse aggregate rather than rock all the same size. Sand is to be sharp, under ¼ in. but with a large proportion of coarse sand in it and free from clay and organic matter. Any sand that soils the hands when it is rubbed between them should be viewed with suspicion and samples taken to determine the amount of deleterious matter in it. No more than 3% of clay is permissible. An excessive amount of clay in the material will usually manifest itself in a reddish tinge in the wet concrete instead of the ordinary gray color of the mixture. Cement of standard brands need not be tested by the inspector. But all cakes, lumps and crusts in the cement must be removed before mixing. Any material which, in the judgment of the inspector is not of the proper quality should be condemned and its use not permitted in the culverts. Clean solid rocks, granite and the like up to 5 in. in diameter may be used in the headwalls below the reinforcing but they must be free from clay coating or organic matter.

POURING

In the standard concrete culverts a proportion of 1 part of cement (by volume) 2 of sand and 4 of coarse aggregate is used. This is about 1.5 to 1.6 bbls. (4 bags to the barrel) of cement to the cubic yard of concrete. The bags are to be counted at the end of the pouring to check the amount of cement used.

CONCRETE

The contractor shall provide some means of measuring the constituents of each batch of concrete mixed or the inspector should furnish him with a schedule of the number of shovels full or wheelbarrows full of materials to use in mixing each batch. Square pointed shovels must be used in all concrete work. Hand mixing should be avoided entirely as with the ordinary highway contractor it is seldom properly done. In mixing the concrete for the floor slab enough water should be added to make the mixture of a jelly-like consistency.

The usual procedure in pouring these culverts is to pour the floor first. Then as soon as it has set to erect the forms for the sides and top. Under favorable conditions the floor has set sufficiently in 24 hours to make it safe to erect the rest of the forms. As a precaution and to keep the floor from being scarred it is advisable to lay plank over the floor for the workmen erecting the forms to walk on. The portions of the culvert floor directly under the headwalls and sidewalls should be left rough and, before pouring the sides and top of the culvert, should be well wet down with water, all *laitance* removed with a broom or spading tool and a thin grout of neat cement applied to insure a sound joint between the floor and side walls. For the sidewalls, endwalls and top more water

directly into the sidewalls or shovel the material in with square pointed shovels.

Spading is very essential to smooth, strong work. It will take two ordinary men, even on the smallest culvert, to spade the material sufficiently. It is exceedingly difficult to make the average contractor realize this fact. If a dry spot is found in a finished wall he will swear by all that is holy the concrete was spaded every minute, that he did it personally, and that the climate or the rate of exchange or anything else over which he had no control is responsible for the defect. But ninety-nine times out of a hundred dry spots and honeycombing are due to poor spading. The hundredth time it is due to a leaky form. Watch the spading especially and see that it is done.

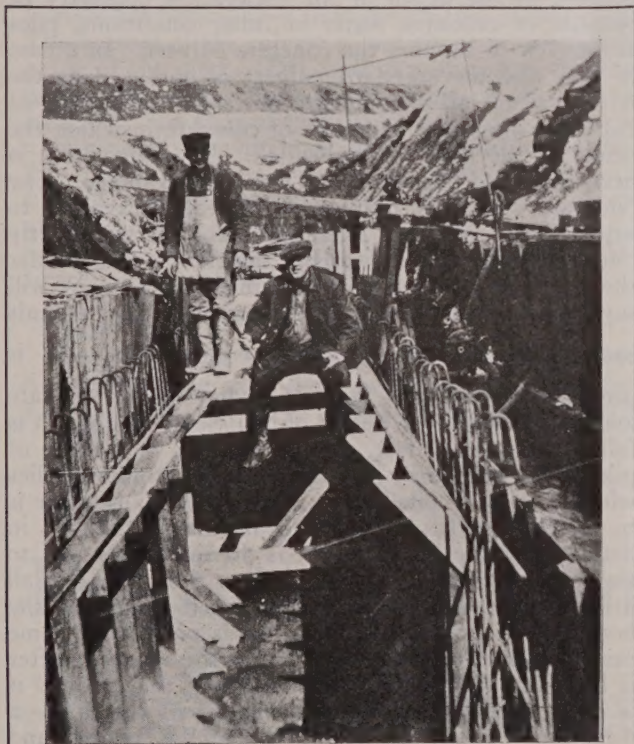
In spading, the spading tool is driven in between the form and the concrete to shove back the coarse material and permit the finer material to run against the form and produce a smoothly finished surface. In addition to spading the concrete against the forms it is important that it should be thoroughly spaded and firmed about the reinforcing rods. Care must be taken that large pebbles do not jam between the rods and forms and make a rough spot in the finished work. The spading must be continuous during the pouring and must cover the same area over and over again. A good spading tool is made by bending the blade of a mortar mixing hoe out in line with the handle of the hoe. This tool, though, is a little large to get between the reinforcing in some culverts and for work of this sort a piece of $\frac{1}{8}$ in. sheet steel 4 in. x 8 in., welded to a handle of $\frac{1}{2}$ in. reinforcing steel will serve nicely. Lacking these tools a 1-in. x 4-in. board beveled to a chisel edge at one end may be used for spading.

FINISHING

The top of the headwall must be troweled to a smooth finish with a steel trowel and the edges of the top worked with an edging tool or beveled off with a $\frac{3}{4}$ -in. or 1 in. 45° bevel strip nailed to the inside of the form. All exposed corners about the endwall and mouth of the culvert must also be finished with similar bevel strips. The floor of the culvert and the top of the culvert may be floated smooth and true with a wooden float. A movable gauge hung from the outside wall forms will aid in working the floor to grade. The inside walls of the barrel usually come out smooth with little attention owing to the tendency of concrete to fall on the top of the barrel and trickle down the inside wall form. But to get a respectable finish on the rest of the culvert the inspector has to assert himself with vigor.

REMOVING FORMS

The concrete of the culvert should be well set before the outside forms are removed. The time of setting will vary considerably with the temperature, humidity and general weather conditions. In warm, dry, clear weather about forty-eight hours must elapse before the outside forms are removed. This is a minimum. In rainy weather, during which the concrete should be covered with tar paper to protect its finish, in cloudy, humid or cool weather the time will be longer. Before removing the outside forms the concrete should be hard enough to bend an eight penny nail before it can be driven to a depth of one inch in the concrete. Be sure the nail does not strike a stone in the mixture. Drive nails in several places in the concrete for this test. The time elapsing before the removal of the forms is strictly a matter of judgment on the part of the inspector and he should not permit the removal of any form until he is sure the concrete is sufficiently set. Inside or core forms should be left in place a



"A LEAKY FORM WILL LEAVE DRY SPOTS IN THE CONCRETE WHERE FROST WILL ENTER AND CAUSE DISINTEGRATION"

may be added to the mixture than was added for pouring the bottom so the mixture may run freely and flow easily. But care must be taken to keep the forms filled all the time to approximately the same level, otherwise the finer part of the mixture carrying the cement will run to the low places, making an uneven mixture and leaving the high points lean and dry. If, on pouring the sides, the concrete is dumped on top of the core and allowed to run into the sidewalls, the finer material will trickle down the inside of the sidewalls and produce a smooth finish with very little attention; but the coarser material will roll against the outside wall and produce a dry, rough surface with little cement in it in spite of all the spading one may do. To avoid this condition either dump the concrete

minimum of ten days in most favorable weather and longer if a heavy fill is to go on top.

All projecting wires in exposed walls and on the inside of the barrel of the culvert should be clipped flush with the surface. A pair of horse shoer's clippers is a good tool for doing this. Or the ends of the projecting wires should be bent over and driven below the surface and a dab of stiff grout smeared over them. This should be done because projecting wires catch floating trash and tend to clog the culvert and also because projecting wires on exposed walls are unsightly.

As soon as the forms are removed and while the concrete is still comparatively green all dry or rough spots in the concrete should be located, the loose and projecting rock removed with a small pick or chisel and a 1:2 or 1:3 mixture of cement and sand filled in the hole and troweled smooth. All broken corners and corners into which the concrete has not run should be made right.

WORK IN COLD WEATHER

While most of the culvert work will be done under the comparatively easy conditions of summertime, there is no temperature at which concrete may not be poured if proper precautions are taken. Some culverts in Northern Minnesota were successfully poured at $\pm 35^{\circ}$ F. Cold weather work is more costly than warm weather work.

For a temperature a few degrees either side of freezing one of the constituents of the concrete should be well heated before mixing. And under all conditions the sand should be free from frozen lumps, which will not always thaw out and mix properly, even when the water has been heated. Near the freezing point tar paper, tarpaulin or 4 to 6 in. of dry earth will protect the poured concrete from freezing but at lower temperatures positive means of heating must be employed. A foot of fresh manure packed about the forms but not in contact with the concrete will serve if nothing better can be contrived. But it is an uncertain protection at low temperatures. Fires built about the culvert are also uncertain and not entirely safe. But salamanders, stoves or steam coils furnish good methods of supplying heat to the concrete. Also a means of retaining the heat must be provided. Where the culvert is built entirely below the surface of the ground such protection may be a heavy tarpaulin spread over and clear of the culvert. But where the culvert is above the surface this covering must be supported on a frame or a plank and tarpaper shack built over the entire construction and projecting well beyond the headwalls. These coverings should be fairly tight to conserve the heat generated by the heaters inside.

In weather much below freezing all the ingredients of the mix should be heated. The water may be heated by dropping hot stones in it, by setting it over a fire in a large tank or by running live steam in it. The commonest way of heating the sand and rock is by building a fire in a 24-in. corrugated metal culvert and piling the material to be heated over the top of the pipe. Heat is also introduced into sand and gravel by means of perforated steam pipes run under the piles of material or driven into the pile as steam points.

In very cold weather only the portion of the forms in which the concrete is being poured should be exposed. The rest should be kept covered and the heaters in operation. However care must be taken that too high a temperature is not maintained as this will dry out the concrete too quickly and produce dangerous and ugly cracks. Under favorable conditions the concrete will have obtained sufficient set in about three days to make it safe to remove outside forms and stop heating. But if it has been possible to

maintain a temperature only slightly above freezing, this period will have to be extended considerably.

Concrete frozen once and for some time may develop its full strength but the process is much longer than normal. Concrete frozen and thawed alternately a few times is almost certain to be worthless and should be inspected with the return of warm weather. Should this inspection reveal spalling or cracking or softening of the concrete the culvert should be rebuilt. Frozen concrete may be detected by laying the bare palm of the hand against the concrete suspected. If the concrete is frozen drops of moisture will show on the palm of the hand when it is withdrawn from contact with the concrete. If merely set the hand will show no trace of moisture. Frozen concrete may seem as hard as well set concrete but it is hardly as strong—nor as permanent.

Inside forms may be left in place all winter if there is traffic over the culvert and if the spreaders have been knocked out to prevent the forms from swelling and cracking the concrete.

PILE CULVERTS

In deep soft ground, as in muskeg, where it is impracticable to dig to solid foundation and backfill because of the depth of the excavation necessary or because of excessive water or other conditions, piles are driven to support the concrete culvert. In a case of this sort the standard culvert is not used as the bottom is not massive enough but a specially designed culvert is provided with ribs of concrete in which the heads of the piles are imbedded. The excavation is first made and provided with means of drainage. The piles are driven in the bottom of the excavation to support the culvert. These piles are placed directly under the side and endwalls of the culvert—not under the floor—and driven down till theoretically they will support a weight of ten short tons or 20,000 pounds each. The *Engineering News* formula $P = \frac{2Wh}{s+1}$ is

used to compute this bearing power where P is safe load in pounds, W is weight of hammer in pounds, h is fall of hammer in feet, s is penetration or sinking of pile under last blow, in inches. This formula applies where a gravity pile driver is used. The inspector is to see that each pile is sound and at least 12 in. in diameter at the butt, that it is driven to line and to the proper bearing depth. When the piles are all driven they are sawed off square and to grade and the bottom slab poured on them. It is possible in some cases to place concrete directly on the muskeg after it has been trimmed to shape. When this is done it is often necessary to place a bleeder in the floor—a 6-in. pipe—about which the concrete is poured and through which the water impounded below the concrete is allowed to escape into a trough, which in turn conveys it beyond the limit of the concrete or to the pump. But in most cases it is better to make forms for the bottom of the culvert floor as well as for the rest and suspend them substantially from the piles themselves. Then one will be independent of the nature of the ground, the amount of concrete and the thickness of the floor can be gauged and the concrete can be kept clean and free from excess water. As the piles eventually support the whole weight of the concrete no strength is sacrificed by using these bottom forms and the ease and economy with which concrete can be poured into them is well worth the additional expense involved in building these forms.

BACKFILLING

Clayey loam, sandy loam and sand and gravel with some clay are the best materials for backfilling around

a culvert. The materials must be shoveled in in layers five or six inches deep and thoroughly tamped and compacted with a heavy tamper. Extra care should be taken with the tamping around the headwalls. This compacting of the backfilling is to prevent water entering and making channels beside and under the culvert and causing the culvert to settle. It is best to fill the culvert excavation on both sides at once so no lateral pressure is developed against one side only of the culvert. This is important in the case of pile culverts.

RIPRAP

Riprap should be placed above the headwalls, in high fills, about the culvert endwalls and at the inlet and outlet of the culvert. The rock used should be about the size of a man's head. This should be evenly and firmly bedded in place, forming a smooth surface. In the interstices should be rammed spalls of rock to wedge and hold the riprap in place. Riprap should be placed at least a foot in thickness.

CORRUGATED METAL CULVERTS

Corrugated metal culverts are laid at road crossings and farm entrances and sometimes under railroad embankments. They are laid in trenches of which the bottom has been shaped to fit the contour of the culvert. The bottom of the culvert is laid about 4 in. below the grade of the ditch. Dry wall of a minimum thickness of one foot and a slight batter is placed about a foot back from the ends of the culvert and a floor extending up the sides of the ditch and along the bottom for about 2 feet is laid. The drywall and floor must be neat, smooth and workmanlike and must be laid of rock about the size of a man's head. Spalls are wedged in between the larger rocks. The above applies as well to sectional concrete culverts.

RECORDS

A record must be kept by the culvert inspector, first in his field note book and monthly report form and later in the office culvert book, of the location

(station), kind, size and length of culvert built, yardage and classification of excavation, yards of concrete poured, pounds of steel reinforcement placed, date of completion of culvert and yards of riprap placed about it. Also he must record date of pouring bottom and date of backfilling and permitting traffic over the culvert, together with any other notes of interest or unusual conditions met with in the construction.

IN GENERAL

I have found little inclination on the part of the contractor to skimp the amount of cement used. He keeps fairly close to the specified proportion. But he is careless about the grade of his sand and gravel, about the placing to exact position of his steel and about the amount used, about the correct splicing of the steel and about the matters of adequate bracing of forms and stiffening them, particularly headwalls. He avoids proper spading of concrete and he likes to take the forms off the concrete while it is still green. Also he sits up nights devising excuses for filling deep fills or driving steamshovels over newly set concrete. And all in all, he is a pretty human sort of fellow.

In all the inspector's work a certain amount of latitude is allowed. And common horse sense should tell him when to apply the letter of the law and when to allow deviation. The inspector should plan his work so he will interfere as little as possible with the work of the contractor and make up his mind as to whether he will accept or reject material before any amount of it is delivered on the ground. It pays to be as decent as possible with the contractors and their foremen as you will probably be working together for months on the job and it helps neither your work nor theirs to be at loggerheads all the time.

The inspector should read before he begins work at all a copy of the state specifications covering his work. These notes are intended merely as a supplement to that document. In addition he should make himself thoroughly conversant with any literature accessible on monolithic culvert construction and on concrete construction in general.

Protection of Concrete Against Alkali

From a Progress Report by Dr. E. C. E. Lord, Petrographer, U. S. Bureau of Public Roads, in *Public Roads*, published by the Bureau, of two series of tests by U. S. Bureau of Public Roads, employing water-gas and coal tars and paraffin treatments.

Two series of investigations by the United States Bureau of Public Roads directed toward the development of treatments for concrete to protect it against attack by alkali have yielded certain results which are worthy of notice, although the investigations are still in progress, and it is not yet possible to report definitely with regard to the relative success of the several treatments studied.

Only one form of treatment was tried in the earlier experiments, that being immersion in thin, crude water-gas tar.

The specimens employed in the first experiments consisted chiefly of sections of well-seasoned, 6-in. concrete drain tile containing very little coarse aggregate, and ordinary tension and compression strength specimens made up of one part cement and three parts sand. In addition to these samples, concrete

and mortar specimens were prepared for tar penetration determinations.

The tile sections, after thorough drying in air, were immersed in thin, liquid water-gas tar at room temperature for a few minutes until all air had been expelled, when they were removed from the bath and allowed to drain and dry out in air, or they were heated in the air bath at 110° C. for four hours. In some cases, two treatments of this kind were given, in order to assure a complete penetration of the tar. It was found that the maximum amount of tar absorbed in this way was from 7 to 8% after draining for 24 hours, and about 4½% when dried in the air bath.

The mortar specimens for tension and compression tests were treated in the same way, but allowed to remain in the tar for six days before drying in the air bath.

PROPERTIES OF THE WATER-GAS TAR

Tests of the tar used showed the following properties:

- 1. General characteristics. Very thin liquid
- 2. Specific viscosity (Engler) 3.17 at 25° C.
1.98 at 40° C.

3. Total bitumen soluble in CS ₂	Per cent.	96.99
4. Free carbon.....	do.	0.30
5. Inorganic matter.....	do.	0.05
6. Water.....	do.	2.66
7. Distillation (170° C.-300° C.).....	do.	42.2
8. Residuum (semi solid).....	do.	57.8
9. Specific gravity (25° C.).....		1.053
10. Specific gravity of distillate (25° C.).....		0.956

In order to estimate the penetrating value of this tar, 4-in. x 2-in. sand mortar cylinders were prepared, which, after curing for seven days in damp air and drying in the laboratory for six days, were placed in glass stoppered jars containing 25 cu. cm. of tar. After one month it was found that the tar had penetrated uniformly upward to a height of from $2\frac{3}{4}$ to $3\frac{3}{4}$ in. above the original level of the tar.

EXPOSURE TESTS

Prior investigation by the Department of Drainage and Waters of Minnesota¹, in connection with a study of the effect of alkali on concrete drain tile, had indicated in some cases a loss from the cement of about 30% lime and the formation of gypsum (hydrrous sulfate of lime) in large quantities. In view of these results, it was decided to expose the test specimens to a solution containing $1\frac{1}{2}\%$ sodium sulfate and $1\frac{1}{2}\%$

TABLE 1—SOLUBILITY OF TAR-TREATED AND UNTREATED CONCRETE DRAIN TILE IN 3% ALKALI SOLUTION

Sample No.	Weight of sample	Method of treatment	Time exposed	Loss of CaO	Remarks
I.....	Grams 2,297	Immersed twice in tar and dried at 110° C.	Weeks 6	0.56	
			10	1.31	
			14	1.65	
			18	1.52	
			22	1.45	
			26	2.10	
			30	2.18	
			38	2.10	
			Total.....	2.45	
II.....	2,198	Immersed once in tar and dried at 110° C.	7	0.61	
			12	1.87	
			16	0.82	Solution renewed.
			24	1.52	
			28	2.35	
			32	2.04	
			36	0.67	Solution renewed.
			Total.....	4.89	
III.....	2,360	Immersed twice in tar and dried at 25° C.	10	1.30	
			14	0.56	
			18	1.58	Solution renewed.
			22	1.40	
			26	1.44	
			30	3.06	
			34	2.61	
			38	1.42	
			Total.....	4.36	
V.....	2,171	Untreated.....	5	4.45	
			10	4.38	Solution renewed.
			17	4.02	Do.
			22	3.96	Do.
			26	1.79	Do.
			30	2.29	
			38	5.40	
			42	4.04	
			46	1.08	Solution renewed.
			Total.....	23.29	
v.....	2,281	Untreated.....	2	2.40	
			3	2.19	Solution renewed.
			4	1.25	Do.
			6	0.50	2 weeks in tap water.
			10	4.18	Solution renewed.
			14	2.76	Do.
			18	1.13	Do.
			22	1.44	
			26	2.40	
			30	2.25	
			34	0.67	Solution renewed.
			38	1.81	
			Total.....	17.49	

magnesium sulfate, which approximates an average maximum concentration of these salts in alkali soil waters, and determine the amount of lime passing into solution as a measure of alkali attack.

The tests were carried out as follows: Sections

of tile, both treated and untreated and weighing approximately 2200 grams, were placed in porcelain-lined jars containing 10,000 cu. cm. of the alkali solution and kept well covered. Determinations of lime were made from time to time and the solutions renewed at frequent intervals. Table 1 shows the loss of lime after various periods of exposure and the total lime dissolved at completion of the tests.

It will be seen that the lime dissolved in the untreated samples (Nos. IV and V) does not increase progressively with the time exposed, but after reaching a maximum (about $4\frac{1}{2}$ grams in 5 weeks) appears to decline, owing possibly to the formation of insoluble calcium sulfoaluminate compounds. Comparing the total loss of lime in the untreated samples (IV and V) with that of the treated (Nos. I, II, and III) for the same length of time (38 weeks) it will be observed that the former have lost from 7 to 9 times as much lime as No. I, which received a double tar treatment, and from 3 to 5 times as much as the samples given but one treatment (No. II), or two treatments and dried at 25° C. (No. III). In other words, it may be said that the foregoing results indicate a 7 to 9 fold protection in the case of thoroughly impregnated material (I), and about 4 fold when insufficient tar was absorbed (II), or where the fixation of the tar residuum was incomplete before exposure to the alkali solutions (III).

TENSION AND COMPRESSION TESTS

Tension and compression tests were made on mortar treated with water-gas tar and on untreated material after remaining in 3 and 10% alkali solutions and in tap water for 28 and 182 days. The results are given in Table 2.

It will be observed that while the untreated samples failed completely after 6 months in 3% alkali solution (2), the treated specimens (3) gave higher values for tension and about the same for compression as those stored in tap water for the same length of time (1). Treated samples stored in 10% alkali solution (6) showed a loss in tension of about 50 lb. as compared with untreated samples after 6 months in tap water

TABLE 2—STRENGTH OF TAR-TREATED AND UNTREATED MORTAR AFTER ONE AND SIX MONTHS IN WATER AND ALKALI SOLUTIONS

Sample No.	Treatment	Storage solution	Tensile Strength		Compressive strength	
			28 days	182 days	28 days	182 days
1.....	Untreated.....	Tap water	Lbs. per sq. in.	Lbs. per sq. in.	Lbs. per sq. in.	Lbs. per sq. in.
			412	360	1,925	2,540
			435	362	1,995	2,480
			397	362	1,575	2,830
			Average.....	415	361	1,852
2.....	Untreated.....	3% alkali	230	Disintegrated.	1,908	Disintegrated.
			220		2,300	
			235		2,230	
			Average.....	228	2,143	.....
3.....	6 days in water-gas tar.	3% alkali	390	592	2,610	2,312
			495	490	2,340	2,432
			568	568	2,462	3,000
			Average.....	484	550	2,471
			.....	.....	.....	2,581
4.....	Untreated.....	Tap water	463	402	.....	.....
			400	418	.....	.....
			406	396	.....	.....
			442	.....	.....	.....
			Average.....	427	405	.....
5.....	Untreated.....	10% alkali	480	184	.....	.....
			390	135	.....	.....
			417	70	.....	.....
			Average.....	429	130	.....
						
6.....	6 days in water-gas tar.	10% alkali	515	363	.....	.....
			502	330	.....	.....
			465	370	.....	.....
			463	.....	.....	.....
			Average.....	486	354	.....

¹Report of Concrete-Alkali Investigations in Minnesota. State of Minnesota Department of Drainage and Waters, E. V. Willard, Commissioner, 1919-20, pp. 13-16.

(4), but were 224 lb. stronger than untreated samples (5) stored in 10% alkali solution for the same length of time.

From these results it was concluded that water-gas tar if thoroughly incorporated in concrete offers, for a considerable period at least, an effective protection against the action of saline solutions.

SECOND SERIES OF TESTS

These preliminary investigations of the treatment of concrete with water-gas tar as a protection against alkali attack gave such encouraging results that the work was continued on a somewhat larger scale with coal-gas tar and paraffin in addition to water-gas tar as waterproofing materials.

The test pieces consisted of 4- x 6-in. cylinders made up of portland cement, Potomac River sand, and gravel in the proportions of 1:1½:3, 1:2:4, and 1:3:6, which, after curing for 28 days in damp sand, were allowed to dry out for at least two weeks before being treated.

Four cylinders of each batch were treated as follows: One was painted with 6 coats of crude water-gas tar; one was painted with 10 coats of crude water-gas tar; one was painted with 10 coats of crude water-gas tar followed by 1 coat of coal-gas tar thinned with benzol; and one was immersed for 24 hours in a 20% solution

of paraffin and kerosene, after which it was painted with 4 coats of the same solution. Water-gas and coal-gas tars were applied at normal room temperature; for paraffin treatment the concrete and solution were maintained at a temperature above 82° F.

After receiving the above treatment, four cylinders of each batch, together with four untreated specimens, were stored in porcelain-lined, covered cans containing 1600 cu. cm. of a 3% solution of sodium and magnesium sulfate. At monthly intervals, the specimens have been removed from the sulfate bath, allowed to dry out at room temperature for 48 hours, and weighed, and the gain in weight and loss in lime determined. This procedure will be continued until evidence of failure is noticeable in the untreated samples, when all cylinders will be tested for compressive strength, and the broken material will be examined microscopically and chemically.

In Table 3 the results are recorded at monthly intervals extending over a period of 10 and 12 months' exposure to the action of the alkali. It will be observed that the effect of the tar treatment is similar for all concrete mixtures, and that samples Nos. 10, 11, and 12, receiving 10 coats of water-gas tar and 1 coat of coal-gas tar, indicate a minimum loss in lime and increase in weight. This is especially noticeable in the 1:2:4 mixtures (Nos. 2, 5, 8, and 11) where the loss in lime in 12 months is 14.5 grams for untreated samples (No. 2) and only 0.7 gram for samples treated with water-gas and coal-gas tars (No. 11), while the gain in weight, through absorbed moisture and secondary salts, is 416 grams for the untreated and only 116 grams for the sample treated with the two tars after 12 months' exposure to the alkali solution.

In regard to the paraffin treatment, it will be noted that samples from all batches receiving 4 coats of the paraffin solution after saturation (Nos. 15, 16, and 17) indicated about the same resistance to alkali attack as the tar-treated samples (Nos. 10, 11, and 12), whereas samples immersed for 24 hours in the paraffin bath but receiving no surface application of paraffin (No. 14) suffered an appreciable loss in lime after 8 months' exposure to the action of the alkali solution. The fact that gain in weight is not correspondingly large may indicate that the action which is taking place is confined largely to the surface of the specimens.

TABLE 3—ACTION OF ALKALI SOLUTION ON CONCRETE TREATED WITH TAR AND PARAFFIN

Sample No	Treatment	Mix	Weight of samples	Loss of CaO in grams by months									
				1	2	3	4	5	6	7	8	9	10
1	Untreated	1:1½:3	Kilo-grams 10.684	7.7	9.2	9.2	9.2	9.4	9.4	10.4	11.2	12.2	12.2
2	do.	1:2:4	10.688	10.8	11.6	12.8	13.1	13.9	13.9	13.9	13.9	13.9	14.5
3	do.	1:3:6	10.504	7.9	9.6	10.6	10.9	11.5	11.6	12.2	12.9	13.7	13.7
4	6 coats of water-gas tar	1:1½:3	10.640	3.8	4.8	5.5	5.9	6.3	7.5	8.0	8.6	9.2	9.2
5	do.	1:2:4	10.872	7.5	8.6	10.3	10.3	11.0	11.6	11.6	11.8	11.8	12.8
6	do.	1:3:6	10.504	5.6	6.8	7.5	7.8	7.8	7.8	9.1	9.4	9.8	9.8
7	10 coats of water-gas tar	1:1½:3	11.120	4.3	5.7	6.2	6.7	6.7	7.1	7.1	7.7	7.7	7.7
8	do.	1:2:4	11.084	3.4	3.4	3.4	3.4	4.1	4.3	4.3	4.5	4.5	4.5
9	do.	1:3:6	10.852	3.2	3.9	4.9	4.9	5.2	5.2	5.7	5.7	6.7	6.7
10	10 coats of water-gas tar, 1 coat of coal-gas tar	1:1½:3	11.324	0.3	1.4	1.1	0.4	0.4	1.1	1.4	1.4	1.6	1.8
11	do.	1:2:4	11.052	.0	.0	0.2	0.3	0.3	0.3	0.3	0.7	0.7	0.7
12	do.	1:3:6	10.888	0.2	0.7	1.4	2.1	1.9	1.8	1.8	2.0	2.0	2.7
13	24 hours in paraffin-kerosene	1:1½:3	11.853	...	5.0	5.9	5.9	6.0	6.4	6.4	6.4	...	...
14	24 hours in paraffin-kerosene, 4 coats paraffin	1:1½:3	11.411	0.6	0.6	0.7	1.1	1.1	1.1	...	...	...	...
15	do.	1:2:4	11.596	.0	0.6	0.8	1.1	1.1	...	...	...	...	...
16	do.	1:3:6	11.416	1.2	1.2	1.2	1.2	...	...	...	...	...	...
17	do.	1:3:6	11.416	1.2	1.2	1.2	1.2	...	...	...	...	...	...

Sample No.	Treatment	Mix	Weight of samples	Gain in weight (grams) by months									
				1	2	3	4	5	6	7	8	9	10
1	Untreated	1:1½:3	Kilo-grams 10.684	304	300	340	340	332	332	332	336	336	348
2	do.	1:2:4	10.688	400	416	404	428	...	444	440	436	424	432
3	do.	1:3:6	10.504	424	416	452	452	476	472	440	464	436	444
4	6 coats of water-gas tar	1:1½:3	10.640	176	156	180	180	172	172	180	180	186	184
5	do.	1:2:4	10.872	276	284	260	288	...	300	292	292	288	288
6	do.	1:3:6	10.504	288	296	324	324	336	332	328	332	320	320
7	10 coats of water-gas tar	1:1½:3	11.120	112	120	148	148	140	140	148	148	148	156
8	do.	1:2:4	11.084	148	164	160	184	...	192	192	188	184	184
9	do.	1:3:6	10.852	172	184	212	212	232	236	228	244	232	232
10	10 coats of water-gas tar, 1 coat of coal-gas tar	1:1½:3	11.324	80	84	96	96	88	88	92	100	88	92
11	do.	1:2:4	11.052	132	136	124	126	...	144	136	132	128	132
12	do.	1:3:6	10.888	124	126	160	160	172	176	168	180	172	172
13	24 hours in paraffin-kerosene	1:1½:3	11.853	64	100	108	104	100	108	104	108	...	...
14	24 hours in paraffin-kerosene, 4 coats of paraffin	1:1½:3	11.411	56	64	60	68	72	72	...	...	...	...
15	do.	1:2:4	11.596	104	112	128	124	124	...	...	...	...	...
16	do.	1:3:6	11.416	152	180	176	188	...	...	...	...	...	...
17	do.	1:3:6	11.416	152	180	176	188	...	...	...	...	...	...

Concrete Floors for Railway Cars

Iron and wood floors in railway cars in Germany may be replaced by concrete if experiments recently conducted there prove successful, according to a report from Consul General E. T. F. Dumont, Frankfort. A composition designated as "Eisenbeton" or "ironwood" had been used in the construction of the floors of railway freight cars with a great measure of success. The first car made of "Eisenbeton" was built in 1919 by a railway car manufacturer and a portland cement concern in Heidelberg and tested in the railroad freight yards. The car it is reported withstood concussion at a speed of 27 kilometers and shifting tests were so satisfactory that after five years of service this test car still remains in perfect condition.

The new type of car weighs 20 tons and in appearance is much the same as an ordinary iron car. The cost of manufacture is said to be much less than for iron and although the concrete car is much heavier, the fact that the danger of rust is eliminated offsets this disadvantage in the opinion of the builders. The car with the concrete floor requires so little repair, the report says, in comparison with wood and iron cars that the railway administration is favorably impressed.

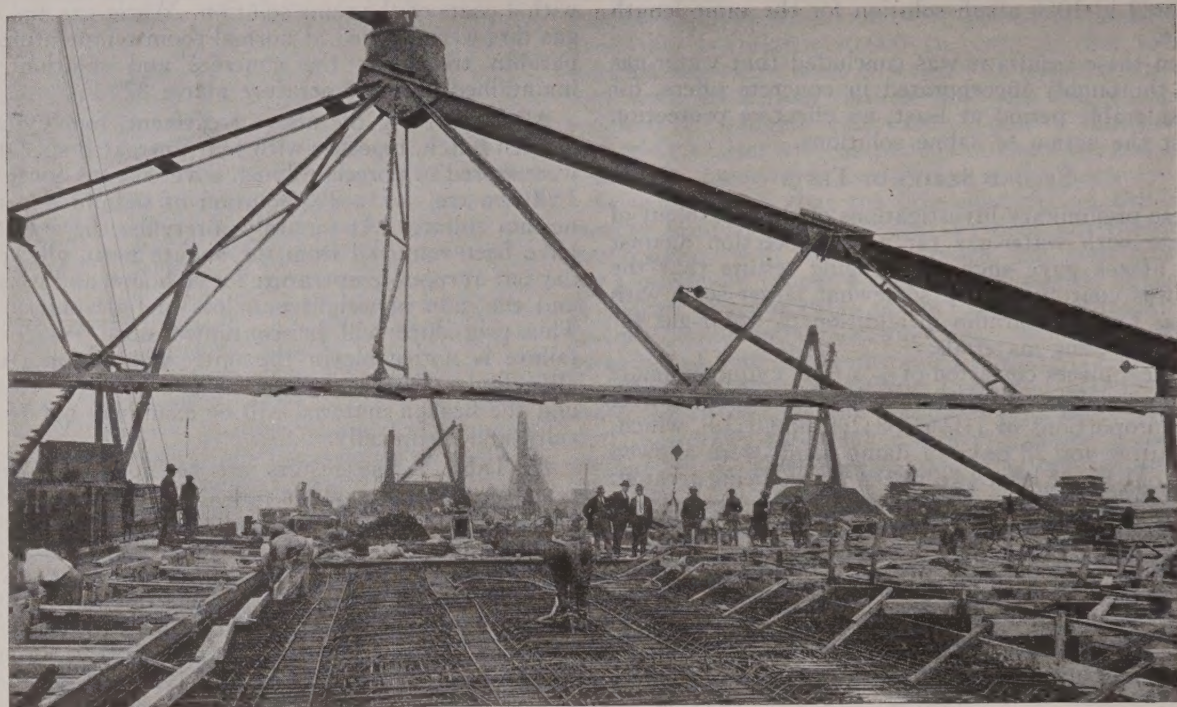


FIG. 1—SOME OF THE CONSTRUCTION EQUIPMENT NECESSARY IN THE CONSTRUCTION OF THE JAMAICA BAY BOULEVARD

Plant for Jamaica Bay Boulevard Construction

BY FRANK W. SKINNER

The Jamaica Bay Boulevard, now under construction by the Borough of Queens, New York City, to provide a direct and capacious highway to Rockaway Beach, decreases the length of the present drive from New York and the Boroughs of Brooklyn and Queens about 10 miles and $6\frac{1}{2}$ miles respectively. Measured by its rapid progress, immediate and complete utility, and large number of direct beneficiaries, there are few of the improvements for which Greater New York has in recent years expended hundreds of millions of dollars that are more successful than the \$3,000,000 Jamaica Bay Boulevard.

It will increase the comfort and convenience of hundreds of thousands of visitors to one of the finest bathing beaches which will be made much more quickly and safely accessible to automobiles and trolley cars.

Considered from a constructional standpoint, the very successful execution of the work is a remarkable achievement. It is notable for the courage, ability and resources that overcome difficulties so serious that they vanquished the first efforts of experienced contractors.

The structure is unique on the Atlantic coast for the great length of the concrete piles driven, for some of the construction details and for the extreme accuracy required. New and powerful plant had to be designed and built for this special work, large quantities of material were provided, special operations were developed and remarkable rapidity was achieved.

It is believed that the speed attained is unprecedented for this kind of work. The record of intricate

form work and concreting and of driving a great footage of very long piles in hard ground, is the more impressive on account of the unforeseen conditions and unusual requirements that were met.

The Boulevard extends south from Woodhaven Boulevard approximately $5\frac{3}{4}$ miles across the shallow waters of Jamaica Bay to Rockaway Beach at Hollands. A wide causeway section of it crosses tidal flats and low marshy ground where the surface of the deep mud and sand has a maximum elevation less than 6 ft. above mean low-water level. It is protected from severe storms, and much of it is submerged by the 5-ft. tides with little current. The wide causeway is constructed of several separate sand embankments aggregating about $4\frac{1}{2}$ miles in length and connected by concrete trestle viaducts in water up to 35 ft. deep, supplemented by plate girder draw bridges of 100-ft. span over two of the main navigation channels. Much of the location is level with maximum grades of 3% to secure necessary elevation for the bridges and the alignment consists of long tangents connected by long radius curves.

Sections aggregating nearly $2\frac{1}{2}$ miles near both ends of the Boulevard, are under construction by private enterprise, and the remainder, 25,000 ft. long including 19,500 ft. of fill and 5,500 ft. of concrete trestle, is being built for the city on a unit price contract and will cost about \$3,000,000.

The contract, at an estimated cost of \$2,863,280.14 was originally awarded to Smith, Hauser & McIssaac, Inc., October 31, 1921 and on October 1, 1922 was



FIG. 2—EQUIPMENT FOR HANDLING REINFORCED CONCRETE PILES AT DOCK FOR TRANSPORTATION TO PILE DRIVER

assigned to Patrick McGovern, Inc. It is now over 90% completed.

CAUSEWAY, VIADUCT AND BULKHEAD

The shallow-water causeway was made with a hydraulic fill of 21 ft. maximum depth and about 350 ft. maximum width at the base, which, in some places, was deposited directly on the original bottom, and in other places was deposited after the soft mud had been dredged, exposing the hard bottom. About 1500 lineal ft. of the fill is protected by a wooden pile bulkhead, the remainder is built with a natural slope of 1 vertical to 20 horizontal on each side of the central traffic portion 100 ft. wide, that consists of a 60-ft. paved roadway and 40-ft. shoulders on a cinder fill 4 in. thick.

The concrete viaduct consists of a floor slab, beams and girders supported on transverse bents of precast reinforced concrete piles. The spans have a practically uniform length of 24 ft. on centers, and the structure will eventually be 100 ft. wide from out to out of parapets. About 2660 lineal ft. is being initially constructed of the full width with an overall width of 52 ft. supported on 7 piles per bent, but will eventually be increased to full width.

The bulkhead consists of a continuous wall of wooden Wakefield sheet piles, 6 in. thick, bolted between double lines of 8x12-in. top and bottom wales. A row of vertical staggered piles 5 ft. apart, is driven on each side of the wales and bolted to them, and alternate piles in the outer row are secured to pairs of inclined anchor piles by 1½-in. inclined screw-end tie rods.

According to the depth of the water, the sheeting is in 18-ft., 24-ft. and 28-ft. lengths, and the vertical piles are in 26-ft., 30-ft. and 36-ft. lengths. All of the timber is creosoted long leaf yellow pine and all of the steel bolts and tie rods are galvanized.

CONCRETE CAST PILES

There are 2194, 24 x 24-in. piles from 50 to 100 ft. long that are used for the regular transverse bents of the viaduct. All were made with 1:1:2 concrete and were seasoned 60 days before driving. The piles con-

tain 0.148 yds. of concrete and 36.76 lbs. of ½-in. round and 1½-in. square reinforcement steel per lineal ft. and weigh 600 lbs. per lineal ft.

A careful study was made of the effect of sea water on submerged concrete, and special precautions were taken by providing a minimum thickness of 3¼ in. of concrete outside of the reinforcement bars, and by jacketing the tops of the piles from 2 ft. below low-water level to 3 ft. above highwater level with a solid casing of two thicknesses of 2-in. creosoted planks secured by horizontal galvanized iron ties 3 ft. apart vertically. The bottoms of the piles were beveled to a blunt point, and the vertical reinforcement bars projected 2½ ft. above the concrete at the upper end to bond with the cast-in-place concrete of the slab and girders.

FLOOR PLATFORM

Each pile bent is capped with a transverse girder, 80 in. high, 12 in. thick, 44 ft. 3 in. or 92 ft. 3 in. long exclusive of end sidewalk brackets. The transverse girders are cast integral with the longitudinal girders, are in the planes of the piles, and are monolithic with the roadway floor slabs 11 in. thick. Under the 12-ft. sidewalk there is a continuous duct chamber 38½ in. deep and 79 in. wide, covered by removable concrete slabs 6 in. thick. On the other side of the roadway there is a continuous depression 12 in. deep and 1½ ft. wide, adjacent to the curb, that is filled with cinders and covered with 5-in. concrete protection slabs which may be removed at any future time to permit laying a trolley track on the cinder fill.

At every third bent there is a regular expansion joint, 2 in. wide transverse to the roadway slab.

The expansion ends of the longitudinal girders have steel bearing plates with transverse angles riveted to their upper sides to bond with the concrete in the beam. The lower side engages a pair of segmental steel rollers seated on a similar bearing plate in a pocket in the transverse girder. Spurs on the roller frame engage recesses in the top and bottom plates and limit the displacement of the rollers.

The sidewalk fences are made with solid precast reinforced concrete panels 5½ in. thick, which at each



FIG. 3—DRIVING LONG PRECAST REINFORCED CONCRETE PILES

end engage horizontal dowel rods cast into the fence posts and are free to slide in the panels.

BEACH CHANNEL ABUTMENT

At the south end of the boulevard the pile viaduct crosses Beach Channel and terminates, at the bulkhead line, with a 30x104-ft. abutment having a 2-ft. reinforced concrete floor slab with the upper surface 3 ft. below low-tide level, that is supported on 102, 24-in. concrete piles up to 63 ft. long. Three sides of the platform are enclosed by the transverse face wall and the two longitudinal side walls that also serve as retaining walls for the earth fill.

The concrete pile tops extend 7 in. above the lower surface of the floor slab, and during its construction, supported the latter on permanent 3-in. form planks resting on pairs of wales bolted to the piles. Just under the transverse wall the concrete piles are braced by inclined wooden piles.

Adjacent to the channel the abutment is enclosed on three sides by a solid wall of 16 x 18-in. reinforced concrete sheet piles about 42 ft. long, with 6 x 6-in. triangular tongue-and-groove installation joints.

CAUSEWAY CONSTRUCTION

The 1,000,000 yards of fill required for the embankment were provided by hydraulic dredges that handled from 6,000 to 14,000 yds. of sand daily. The sand was delivered through a maximum length of 2500 ft. of pipe and to a maximum height of 10 ft. above water-level. The pipe, in 20-ft. lengths, was connected by flange and gasket joints when it was supported on temporary pile trestles and with spherical joints, 90 ft. apart, where it was carried on pontoons. The dredge was operated by a force of about 25 men, including those handling discharge pipe. The highest record made was 275,000 yds. in one month. The dredges were operated to a depth of about 9 ft. and besides providing 1,000,000 yds. of sand for the embankment

furnished 450,000 yds. for fill behind the permanent wooden bulkhead, thus reclaiming about 20 acres of land along the waterfront.

An important feature of the standard methods and equipment for this work, and one that was developed to give great continuous efficiency was the installation for producing the 56,000 yds. of concrete of uniformly high quality, at a sustained rapid rate by the use of only two Rex mixers¹, a stationary one on land for the precast piles and a movable one installed on a scow from which the concrete was spouted to abutments, girders and floor slabs.

PRECASTING LONG PILES

The 24 x 24-in. concrete piles were made one part cement, one part sand and two parts stone of a maximum size of $\frac{3}{4}$ in. mixed for not less than 90 seconds in a 1-yd. Rex machine with a carefully proportioned amount of water not exceeding 45 gal. per cu. yd. Daily tests of concrete, taken from the mixer, showed not more than 6 in. slump in a 16-in. test cylinder. The vertical reinforcement bars were attached to horizontal $\frac{1}{4}$ -in. bands, spaced 6 in. apart from the top of the pile to points from 26 to 35 ft. below it and 12 in. apart beyond this point.

The piles were proportioned for a dead load of 25 tons, live load of 15 tons and impact of 8 tons. There were required in all 2,296 piles which have all been precast and driven.

The pile yard was a level space, about 200 ft. wide and 400 ft. long, which was commanded by a stiff-leg steel derrick with 90-ft. boom, traveling on two longitudinal standard gauge tracks 40 ft. apart on centers.

Sand and gravel were shipped to the yard in barges that were unloaded by 1-yd. and $1\frac{1}{2}$ -yd. Hayward clamshell buckets² serving elevated storage hoppers for the land and floating concrete plants. The land hoppers delivered by gravity to the 23-S new model Rex mixer with batch hopper, power operated discharge and automatic water tank. This mixer delivered concrete to about 14 Keystone 2-wheel carts³ that ran on removable 6 x 12-ft. panels of wooden flooring laid on top of the concrete forms and shifted as the latter were filled.

The casting floor was made of 2-in. planks spiked to carefully leveled sills and serving as a continuous bottom for the forms. The sides of the forms were made of wooden panels 20 ft. long, with 4 x 4-in. vertical cleats 2 ft. apart on centers that had short sections of horizontal angles at the bottom which were nailed to the floor, thus keeping them properly spaced and aligned. The tops of the forms were held rigidly by horizontal transverse spacing boards 10 ft. apart.

The reinforcement steel was bent in a Kardong machine⁴ operated by a 3-horse power General Electric motor⁵, and the rods were assembled and wired together, making for each pile, complete units which were suspended on spacers that elevated them $3\frac{1}{4}$ in. away from both sides of the form while the concrete was poured and tamped around them.

The yard had a capacity for about 125 forms and the

¹Chain Belt Co., Milwaukee, Wis.

²Hayward Co., New York City.

³Gray Iron Foundry Co., Reading, Pa.

⁴Kardong Bros., Minneapolis, Minn.

⁵General Electric Co., Schenectady, N. Y.

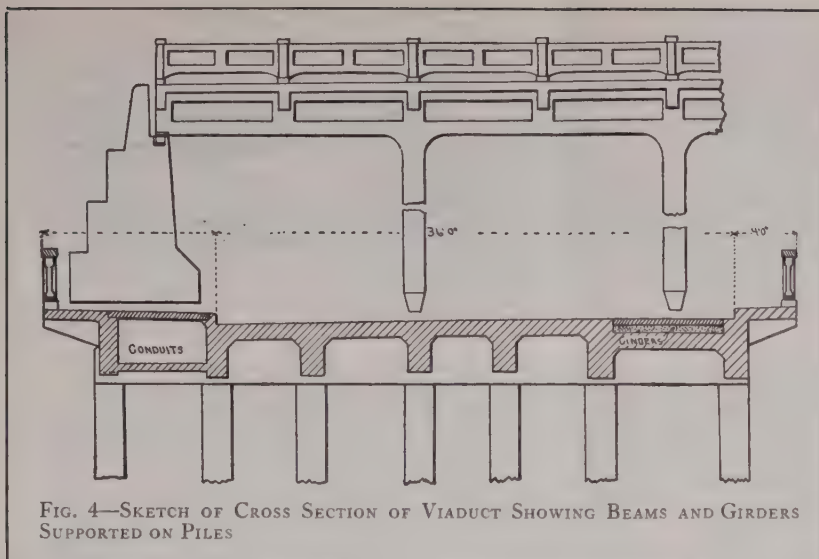


FIG. 4—SKETCH OF CROSS SECTION OF VIADUCT SHOWING BEAMS AND GIRDERS SUPPORTED ON PILES

output of the mixer was about 300 yds. in one 9-hr. shift. An average of about 20 piles per day were cast and after four days were stripped and allowed to season for one month before being stored in tiers, where they remained for at least 60 days before driving.

About 100 piles 93 to 100 ft. long were required, and were precast 90 ft. long and built up to the required length in situ. These piles were driven in water 35 ft. deep with their tops at elevation 26, thus giving them a penetration of about 40 ft.

In the storage yard the piles were piled 3 or 4 tiers high, separated by thin, transverse wooden strips 10 to 12 ft. apart. When handled to and from storage and for driving, the piles were supported at three or more points, the distances between supports being arranged so that the overhanging parts were in no case more than one-half as long as the intermediate parts.

Adjacent to the pile casting floor the contractor established a large general storage and working yard with shops for building and repairing equipment, making forms, bending and assembling reinforcement steel and for miscellaneous service, employing about 100 men including those at the concrete pile plant.

The principal equipment installed or stored here included four derricks with Lambert hoisting engines⁶ and one swinging engine, six Ingersoll-Sargent jack-hammer drills⁷ and one Leyner drill sharpener,⁸ one Schramm portable air compressor,⁹ one cement bag elevator, the usual carpenter and smith shop appliances and machine shop tools for repair work.

PILE DRIVING

All the piles penetrate deeply in the firm, dense sand strata the frictional resistance alone of which was estimated at 400 lbs. per sq. ft. of vertical pile surface, and was relied on, with a proper factor of safety to carry the live load, dead load being assumed to be carried by the direct end bearing.

The character of the bottom; great weight of piles, a maximum of more than 30 tons; the necessity of handling piles so carefully and accurately as not to develop injurious bending stresses; the great length of piles requiring unusual equipment, the heavy driving and the requirements that the piles must be exactly spaced in both directions, accurately centered, have their faces exactly in the planes of the faces of the transverse floor beams and must have their tops driven to accurate

elevation with cut off, made the driving extraordinarily difficult.

The driving equipment at first installed was neither large enough nor powerful enough, and, after the assignment of the contract, was replaced by heavy special plant designed by the contractor and built in 60 days at a cost of about \$75,000 plus \$75,000 of other improvements and extensions to the original contractor's \$320,000 plant, increasing the total outlay for plant alone to \$470,000. The different items of this equipment were selected from the heaviest and best standard and special equipment, purchased separately and combined in the development of a complete driving rig.

A 1000-ton derrick boat was fitted with heavily braced wooden leads 80 ft. high, served by an 80-ft. derrick boom of 50 tons capacity operated by a Lidgerwood hoisting engine¹⁰ with a four-lever quadrant neck. Another Lidgerwood hoisting engine with a four-lever quadrant neck was installed to handle the pile and jet pipes in the leads and to operate capstan heads for various lines. The derrick boat and the service boat alongside with a 750 h. p. battery of steam boilers were equipped with a 6-in. 4-stage Allis-Chalmers centrifugal jetting pump¹¹ driven by a 22 h. p. Terry steam turbine¹² to furnish continuously while each pile was sinking from 20 to 60 ft. four large high pressure hydraulic jets that excavated holes below the pile points. There were also one 6 x 12 x 8-in. Blake & Knowles¹³ and two large Worthington steam pumps,¹³ two 60-ton and three 15-ton Watson-Stillman hydraulic jacks¹⁴, two Albany¹⁵ and two 50-ton Norton jacks.¹⁶

The boat was moored in position by five anchor lines on power windlasses that enabled it to be quickly shifted, adjusted and securely held in approximately the position required to spot the pile. The boats were manned by a crew of 22 men who had quarters on the service boat.

For handling by the large traveler at the casting yard the piles were suspended from the stiff, horizontal bottom chord of a spreader truss about 60 ft. long and 20 ft. deep which was attached to the hoisting tackle of the derrick boom. Four suspended grips, movable on the flanges of the lower chord of the truss, were set at the exact distances required for different length piles.

The piles were transported from the casting yard, a maximum distance of 15 miles to the pile driver on docked scows carrying 14 to more piles at each trip. They were transferred from the scow to the pile driver by a derrick, with its hoisting tackle provided with a 60-ft. steel spreader truss to the horizontal bottom flange of which the piles were lashed in three or four places.

Before the pile was set in the leads, a special steel cap, provided by the Deline Engineering Co. who built the spreader trusses and other steel fittings, and two 3-in. steel hydraulic jet pipes that reached to the point of the pile, where they were secured by an automatically detachable steel clamp. These pipes were arranged one in the center of each side of the pile and

⁶Lambert Hoisting Engine Co., Newark, N. J.

⁷Ingersoll-Rand Co., New York City.

⁸Leyner Engineering Works Co., Littleton, Colo.

⁹Chris. D. Schramm & Son, Inc., West Chester, Pa.

¹⁰Lidgerwood Mfg. Co., New York City.

¹¹Allis-Chalmers Mfg. Co., Milwaukee, Wis.

¹²Terry Steam Turbine Co., Hartford, Conn.

¹³Worthington Pump & Mchry. Corp., New York City.

¹⁴Watson-Stillman Co., New York City.

¹⁵L. J. Kelly Mfg. Co., Albany, N. Y.

¹⁶A. O. Norton, Inc., Boston, Mass.



FIG. 5—SPREADER FOR HANDLING LONG PRECAST PILES

their lower ends were reduced to $1\frac{1}{2}$ -in. nozzles, through which 150-lb. jets were maintained by pressure from a 6-in. main connected to the 3-phase centrifugal pump operated by the steam turbine on the derrick boat. The 80-ft. boom of the pile driver boat derrick assisted in the handling the piles and revolving them to a vertical position in the loads where they were engaged at deck level between a pair of horizontal dogs having a 4-ft. back-and-forth movement controlled by a windlass. The piles were accurately located by transverse measurements and by longitudinal spacing from a guide wire stretched between the 2-ft. projections of horizontal wooden bars clamped to the end piles of each bent. The adjustments permitted the pile to be quickly moved 10 in. in any direction at the top, making its location practically exact.

The piles were driven to an average penetration of about 30 to 40 ft. in 10 or 15 minutes by the action of the hydraulic jets alone. The jetting ceased when the pile top was a short distance above the required elevation, after which the jet pipes were removed. In driving the piles a spacer or follower was used that enclosed and protected the projecting reinforcement bars and received the impact from a No. 11B McKiernan-Terry double-action steam hammer,¹⁷ weighing about 13,000 lbs., which drove the piles 1 or 2 ft. farther to refusal, so that the tops did not require to be cut off. Generally, one week was allowed to elapse after the piles were jetted until they were driven by the steam hammer to the required penetration. A test load of 75 tons was applied to one of those piles one month after it had originally been jetted down. This test load in 3 days caused a settlement of $3\frac{3}{4}$ in., which at the end of the tenth day had not increased. The steam hammer was then applied and a further penetrations of 4 in. to final refusal was obtained.

After some of the piles, driven by the original con-

tractor, had been installed 12 months, they were tested by 150 blows of the 3600-lb. moving part of the 13,000-lb. McKiernan-Terry hammer, striking 110 blows per minute, which brought them to refusal after an additional penetration of 6 in. A maximum of twenty-four 70 to 90-ft. piles per 8-hour day were driven by a force of twenty-two men on the pile driver, coal barge and supply boats alongside. The best monthly record was driving 24,000 lin. ft. of piles in twenty 8-hour days.

CONCRETING THE SUPERSTRUCTURE

Pairs of temporary cross pieces were clamped to the tops of the pile bents and supported the wooden forms for the girders and floor slabs. The girder reinforcement bars were bent, assembled and wired to form complete units at the contractor's yard. They were carefully set in position, secured at the proper distance from the surface of the concrete and the slab reinforcement put in position and wired. The spans were then successively concreted from the floating plant moored alongside. The sidewalk posts are cast in place, engaging dowels that project from the floor slab. Later the panels are to be cast between the posts, completing the regular viaduct structure.

On the 40 x 80-ft. wooden scow for the floating plant there was installed another 23-S $1\frac{1}{2}$ -yd. Rex mixer with engine and automatic water tank. It was fed by gravity from a 10-yd. storage hopper that is filled by a Hayward clamshell bucket operated from the derrick that unloaded adjacent sand, gravel and cement boats. The concrete boat was equipped with an Insley steel hoisting tower¹⁸ 60 ft. high, from which the concrete was spouted through steel chutes, supported by a steel tower boom and a balanced counterweight truss, and having a maximum radius of 72 ft.

This plant was operated by a force of 43 men to place all the concrete above the pile tops. Each 72-ft. regular section of floor slab and girders between expansion joints contained about 440 yds. of concrete, 60 tons of reinforcement steel, bent, assembled, wired and securely fastened in position, many of the bars being wire spliced. About 4 ft. b. m. of lumber were required for each linear foot of form, about $1\frac{1}{2}$ ft. of it being new lumber for each form thus indicating about $1\frac{2}{3}$ times reuse. Each 72 ft. section was concreted in one 14-hour continuous operation and a monthly output of about 3,000 yds. of concrete placed in the viaduct floor was maintained.

The construction of the Boulevard commenced in November 1921 and was about 5% completed October 1, 1922 and was 80% completed October 1, 1923 and was about ready for traffic in July.

The principal quantities include about 14,300 yds. of 1:1:3 concrete in the floor and sidewalks, 15,000 yds. of 1:1:2 concrete in the beams and girders, 4,500 yds. of 1:1:3 concrete in the abutments, 22,200 yds., of 1:1:2 concrete in 150,000 lin. ft. of 24 x 24-in. piles, 4,500 tons of reinforcing steel exclusive of that in piles, 953,000 yds. of embankment of excess of excavation, 28,000 cu. yds. of steam cinders, 35,000 lin. ft. of creosoted piles in bulkhead, 32,000 lin. ft. of creosoted timber piles, 300,000 ft. b. m., of timber sheeting in the bulkhead, 2,800 yds. of abutment riprap, 3,400 yds. of paving riprap, and 1,000,000 ft. b. m., of creosoted pile protection.

The work has been executed with a total force of about 500 men, by Patrick McGovern, Inc., 50 East 42nd Street, New York, under the direction of Capt. James Rice, in charge of engineering construction, Borough of Queens, and C. T. Steiner, assistant engineer.

¹⁷McKiernan-Terry Drill Co., New York City.

¹⁸Insley Manufacturing Co., Indianapolis, Ind.



FIG. 1 — GOVERNOR'S BRIDGE, ROSEDALE, TORONTO, COMPLETED AND READY FOR TRAFFIC

FIG. 2—CONSTRUCTION VIEW SHOWING FALSE WORK ERECTED ACCORDING TO STANDARD TRESTLE PRACTICE

Reinforced Concrete Bridge Construction Involves New Features

The new reinforced concrete bridge over the Belt Line Ravine at Toronto, Ont., embodies some interesting construction features and emphasizes that a perfectly stable and permanent bridge of long spans can be built readily of reinforced concrete over deep ravines. The bridge was designed using stresses and methods of calculation which are now embodied in the New Joint Committee report on Concrete and Reinforced Concrete, and in the standards of the Canadian Engineering Standards Association.

The bridge, constructed at a cost of \$93,000, of which about \$22,000 was for the steel reinforcing, has an over-all length of 672 ft. and the main span of 200 ft. The main span is a rather flat arch with a radius of 215 ft. 4 in. and a rise of 24 ft. 8 in., the height of the span being about 88 ft. above the bottom of the ravine. The structure is 28 ft. 4 in. wide, with approaches 66 ft. wide carrying a roadway 36 ft. wide.

The design submitted by F. G. Engholm, consulting engineer, Toronto, was selected in open competition for the work. The contract was awarded on a unit price basis on the engineer's estimated quantities. In all, 2,068 cu. yds. of concrete were used and 187 tons of reinforcing steel. Superintendence of the construction was also the work of Mr. Engholm.

The Belt Line railway as shown in sections in Fig. 3 was off center with respect to the ravine and as it was desired to have the bridge symmetrical, a minimum span of 200 ft. was required for symmetry and clearance, the west pier being placed as close as possible to the belt line right of way.

Standard dimensions were maintained throughout the entire structure, the classes of concrete were segregated for the contractor and every member was given a number in working out the design details. The

reinforcing for each member was detailed, and the exact bending was given for each rod. Steel orders were worked out, the rods being segregated according to bending. This resulted in absolute accuracy in placing the steel, and efficiency for the contractor and engineer on the job. A live load of 135 lbs. per sq. ft. was assumed in the design. A very complete system of detailing was worked out for the steel. All steel items were listed on detail sheets indicating the number of bars in each item and the diameter and type according to a sheet of typical bends. The steel orders were prepared from the detailed sheets with the number, diameter, type, length, weight per foot and total weight listed and the data was summarized on summary sheets. This enabled the steel manufacturers to supply the reinforcing accurately bent, bundled and tagged and also enabled the contractors to readily place and check the steel.

A very interesting quantity survey of the design was worked out by the engineer. The quantities were listed on sheets provided with spaces for the item number, designation of the item, details, units and quantities. Summary sheets were provided upon which the contractors placed their items at an estimated cost per unit, extending the total for the number of units involved. The sum of all these totals represented the price paid on the complete work. This work, while involving more expense for the engineer, gives the contractors an exact basis upon which to work.

Details of the bridge are shown in the accompanying illustrations. The arches are formed of two ribs and an arch slab supporting transverse beams upon which rest the reinforced concrete deck. Beams cantilevered from the arch rib carry the sidewalks and parapets, as well as

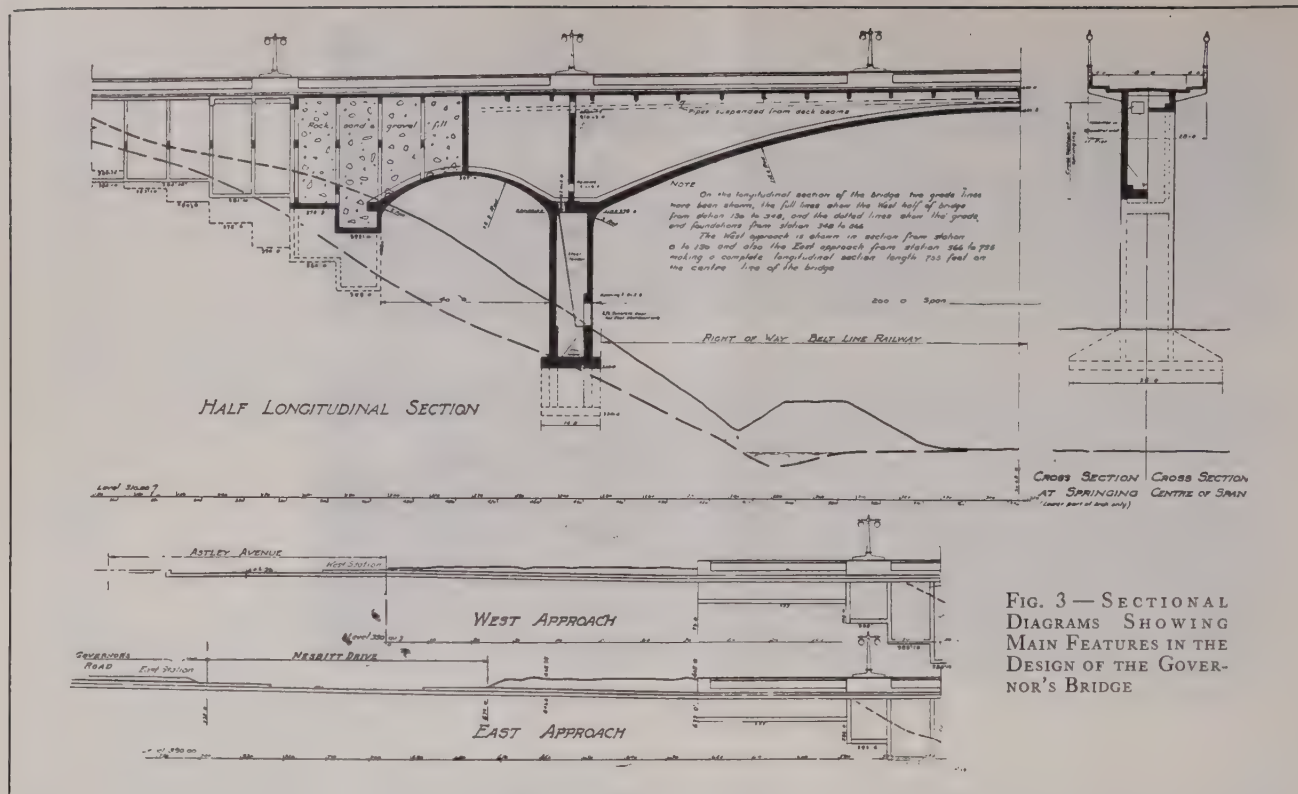


FIG. 3—SECTIONAL DIAGRAMS SHOWING MAIN FEATURES IN THE DESIGN OF THE GOVERNOR'S BRIDGE

part of the road slab. Cross spandrel walls shown in the half longitudinal section in Fig. 3 join the arch ribs over the piers and at the crowns of the secondary arches. The radius of the secondary arches is 26 ft. 9 in. giving a rise of only 9 ft. The arch slab for the main arch is 9 in. thick at the crown and 21 in. thick at the springing and that for the secondary arches 9 in. thick at the crown and 27 in. at the springing.

The piers which support the arches are hollow, being built up of thin walls of reinforced concrete. The piers and abutments rest on firm clay. The outside pier walls are 15 in. thick being carried by spread footings consisting of slabs 2 ft. 6 in. thick and 14 ft. x 36 ft. in plan. The spread footings also have two vertical ribs 2 ft. thick and 7 ft. 6 in. high. All footings, ribs and walls are of reinforced concrete and the abutments which are also built up of thin walls are reinforced and tied together with cross beams, the interior being filled with rock, sand and gravel up to the cross spandrel walls at the crown of the arch. The construction of the piers is shown in the accompanying illustration, Fig. 4.

The main reinforcing rods in the slabs and ribs are $2\frac{1}{2}$ in. in diameter, and all steel was very carefully detailed and electrically welded after being placed in the proper position.

Fig. 3 shows a cross section of the structure at the springing line and at the center of the span. This illustrates how the arch slab, ribs and the roadway slab, taken as a unit have the appearance in section of a box girder.

As shown in Fig. 6, the width of the bridge between outside faces of handrails is 28 ft. 4 in. The roadway is 18 ft. wide between curbs and the sidewalks have a clear width of 4 ft. from the inside face of the parapet wall to the curb. The pavement has a crown of 3 in. and the sidewalks a fall of $1\frac{1}{2}$ in. toward the curb. The main roadway has a grade of 1 to 80 upwards toward the center of the bridge. Tile drains connected with gulley and catch basins on each side at the ends of the bridge provide outlets into the ravine below. The parapet is of red brick with an Indiana limestone coping. Sixteen lamp posts are provided, each supporting two lamps.

Pipe and conduits are carried under the deck, suspended from the deck beams in the space between arch ribs. Access to the interior of the structure for the purpose of examining pipes is provided by means of a door in the west pier having an opening 2 ft. x 5 ft. 6 in. The door is of reinforced concrete $2\frac{1}{2}$ in. thick.

The approaches to the bridge are 36-ft. concrete roadways on a 66-ft. right of way. The curved wing

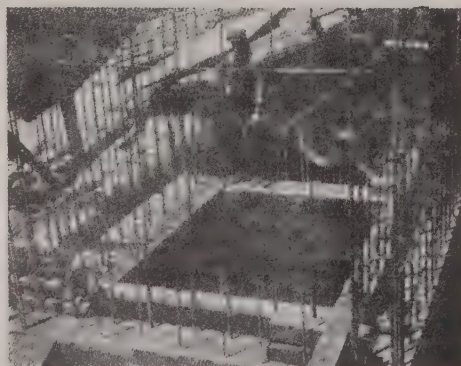


FIG. 4 (LEFT)—PIER UNDER CONSTRUCTION

FIG. 5 (RIGHT)—ELECTRIC WELDER USED TO WELD REINFORCING STEEL

walls are similar to the parapet walls on the bridge. The vertical retaining walls are of reinforced concrete 7 in. thick, ribbed at 10 ft. centers and tied together by cross beams. The cross beams are supported on 18-in. x 18-in. columns midway between the retaining walls. As shown in the illustration of a half longitudinal section, the walls are stepped at the base to conform with the general contour of the ground. The space between the walls is filled with earth and carries road and sidewalk slabs of similar construction to that of the bridge deck. Fig. 6 also shows the layout of the reinforcing steel and Fig. 9 shows the arrangement of the reinforcement at the crown of the arch slab.

As mentioned previously, the main reinforcement of the arch ribs was of 2½-in. diameter rods. These main rods were butt welded at joints, all butt welds being built up to approximately 25% in excess of the original areas of the rods, so as to insure the development of their full strength. Diagonal tension members were lap welded to the main tension and compression rods and the vertical stirrups lap welded together and welded to certain rods at the top and to the compression rods at the bottom. The vertical rods in the abutment were welded to certain of the top rods and the rods in the ties at the abutment and retaining walls were welded to the main vertical rods. The welding at intersections, other than that of main rods, was to properly secure the rods in position.

Standard trestle practice was followed in framing the arch centering using bents in 14-ft. lifts, constructed of 6-in. x 6-in. timbers. This light centering supported on oak mud sills, although light for the span and height of the bridge was considered sufficient as practically all the weight that the trestle would have to carry was the soffit of the arch. The tension bars carried the cantilevered portion of the arch during construction. A

careful check on the action of the centering when the concrete was poured showed the amount of settlement to be negligible. In designing the false work, the concrete was considered as liquid with a weight of 180 lb. per cu. ft. for vertical loading and 120 lb. per cu. ft. horizontal pressure.

As the whole structure was designed with the idea of standardization of forms as far as possible, construction of the forms for the floor slab and slabs in the retaining wall was largely repetition work, only three types of bays being used in the entire work.

As the nature of the design of the bridge limited the amount of concrete to be poured in any one day, a large concreting plant was not required and the average daily pour was from 30 to 40 cu. yds. of concrete with a maximum of 156 cu. yds. attained in pouring the arch slab. The proportions maintained were 700 lbs. of cement to 18 cu. ft. of fine aggregate to 27 cu. ft. of ¾-in. coarse aggregate.

In carrying out the construction work, the general contractor, the Goldie Construction Co., Toronto, constructed the piers and abutments up to the base of the secondary arch piers and then proceeded with the approach retaining walls. The false work for the main arches, for the secondary arches and for the arch rib steel was erected in order and then the steel placed for the main arch ribs and secondary arch slab. Following the pouring of the secondary arch slab, the secondary arch ribs, abutments and cross spandrel walls were constructed, and the approaches filled in over the secondary arches. After the decking to the secondary arches was constructed, the main arch slab was poured and the main arch ribs to the soffit of cantilever beams followed by the main decking, approaches and parapet walls.

The main features of the work effectual in keeping

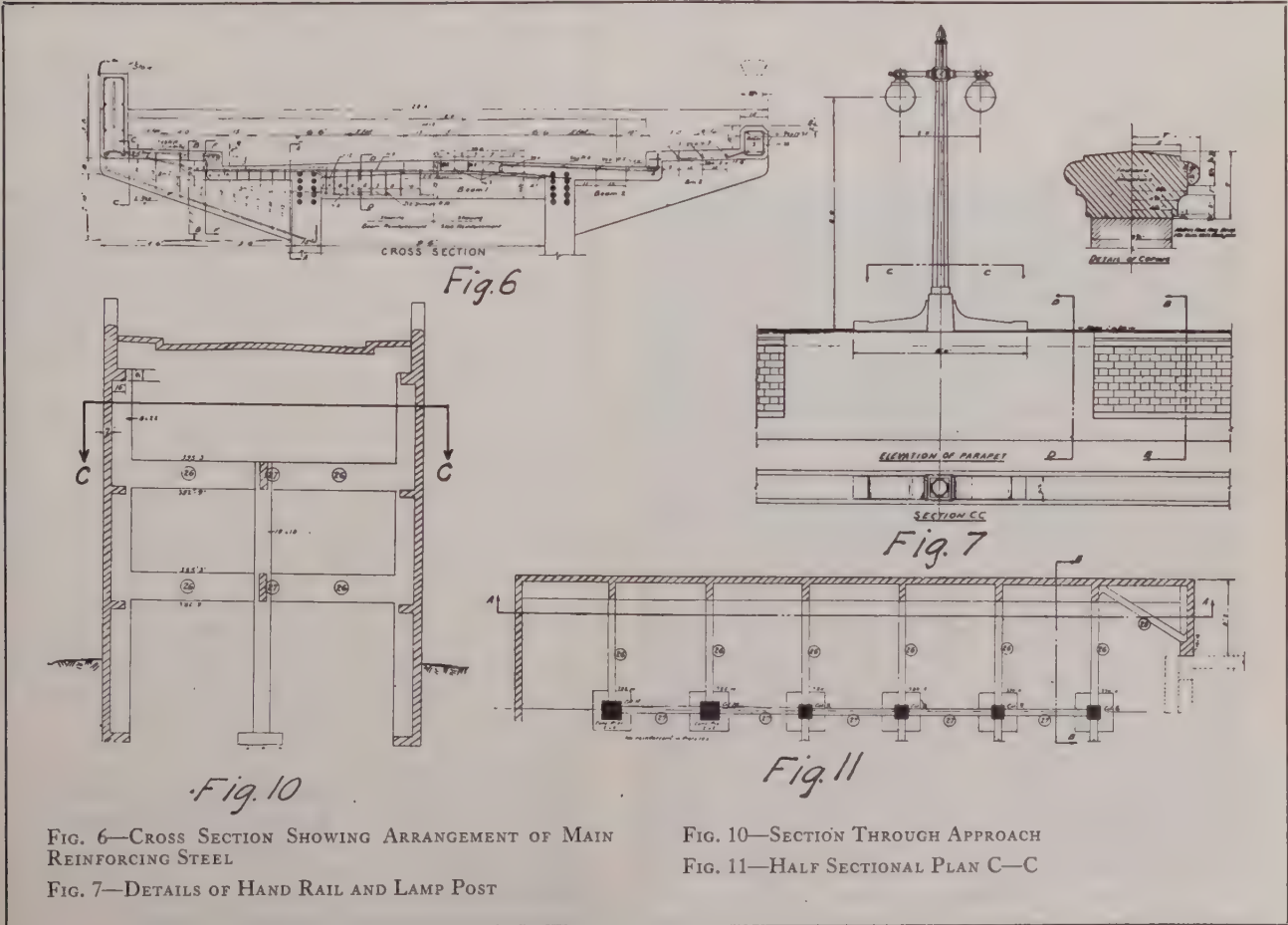


FIG. 6—CROSS SECTION SHOWING ARRANGEMENT OF MAIN REINFORCING STEEL

FIG. 7—DETAILS OF HAND RAIL AND LAMP POST

FIG. 10—SECTION THROUGH APPROACH

FIG. 11—HALF SECTIONAL PLAN C—C

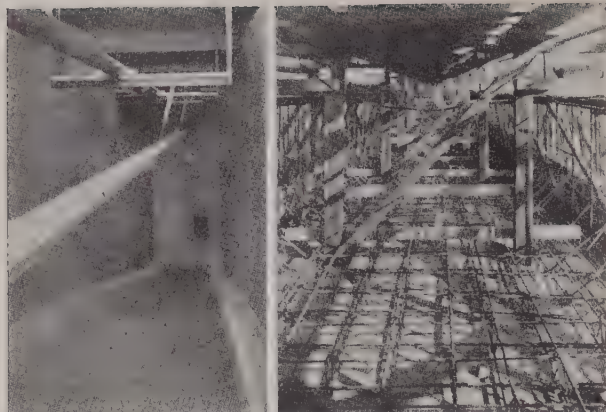


FIG. 8 (LEFT)—INTERIOR OF BRIDGE, LOOKING FROM CROWN OF ARCH TOWARD PIER SHOWING PIPE AND CONDUIT SUSPENSION FROM THE BRIDGE DECK

FIG. 9 (RIGHT)—REINFORCEMENT OF CROWN OF ARCH

down the cost of the structure are summarized as follows in *Municipal Improvements*:

1. The lightness of design and the effective way in

which the concrete is used. Practically 100% of the concrete is stressed to working stresses. There is no waste or mass concrete used.

2. The lightness of the main arch ring. The concrete of the whole of the arch ring was poured in one day, starting at 8:30 A. M. and being completed by 5 o'clock. The consequent lightness of the trestle work necessary to carry the load imposed is very different to the massive structure that is usually necessary to carry the heavy arch ribs of large rise, which renders necessary, considerable additional bracing to prevent the trestle work deflecting inwards and rising at the crown when the weight of concrete comes upon it.

3. The design of the concrete work to permit repetition of formwork. The floor slab panels and slab panels in the retaining wall, etc., were all of the same dimensions, namely 9 ft. 4 in. with 8 in. wide beams 10 ft. centers.

4. The extreme care and completeness of the specifications and detailed quantities to give the contractor exact detailed information necessary for him to work out his prices and the definite responsibility taken by the engineer for the accuracy of his work.

The Perfect Cement

The following is a digest translation by E. Lee Heidenreich, of an article by Dr. Eng. Friescke in *Ton-Industrie-Zeitung*, No. 24, 1924.

As a result of the treaty of Versailles the German productive ideas have been concentrated on high-power materials. We must pay special attention to "High-Power" in everything, it is not only an accident, that we represent the leaders in the chemical, optical, and mechanical industry of the world.

According to its nature, the cement market is divided into the following branches:

A—Plain concrete.

B—Reinforced concrete proper.

C—Concrete building blocks, and unit construction items.

D—Other concrete products, pipes, poles, tubs, and the like.

These different purposes demand different qualities in the cement, high compressive, tensile strengths, behavior in expansion or shrinkage, quick setting and quick hardening.

Thus it is always of importance that a rapidly increased compressive strength is accompanied by a corresponding increase in tensile strength, to guard against cracks by stretching of the reinforcements. It seems that the older cements, used by Considere and Hennebique, according to their tests and statements, were superior to the ones in use today in this respect.

When the shrinkage due to the setting of the cement, is added, we at once see the importance of the different qualities of cement for the several purposes.

Knowing that concrete in hardening, shrinks about $\frac{1}{16}$ in. in 39 in., we know that the reinforcement suffers certain compressive stresses before tension sets in, and certain cracks, possibly invisible on the surface, result. Through capillarity these cracks attract water, and keep the concrete around the reinforcement

moist for quite some time, but not enough to rust the steel perhaps, but the danger remains.

Therefore our endeavor must be to produce a cement of tensile, and ductile strength, so as to make a concrete with a minimum shrinkage.

Another quality of importance, is a cement that will prevent spalling off by blows or impacts on the concrete, such as in the case of concrete ties, unit parts of construction, ship building and concrete products.

The adhesion between concrete and steel used to act more like glue, while in the later cements the shrinkage of the concrete in setting seems to be of more importance, as may be noticed in knocking the concrete off from the reinforcements. The connection between concrete and steel formerly was of a seemingly chemical nature, while in the late cements, it appears more mechanical. This change in the cement hardly can be considered advantageous.

Rapid hardening is becoming more and more important, and means in that direction, both chemical, and mechanical (steam curing) are being used.

Finally, a white concrete is becoming very desirable for most of the finer concrete products, as well as for exterior decorations, and our architects keep repeating: "Your stone looks too much like dull cement." Such cement can now be had in the United States, but possibly at the expense of some desirable other qualities.

All these requirements should be met in the perfect cement of the future, and the qualities of the perfect cement must show up in the following items:

A—Color.

B—Start of setting.

C—Influence of increased water on the strength.

D—Compressive strength in 3 and 28 days.

E—Tension and impact strength.

D—Elongation strength.

F—Shrinkage.

G—Resistance to chemical compounds.



FIG. 1—CONCRETE BLOCK IN THE FOREGROUND ARE STILL IN PLACE IN CASTING HOLES. IN THE REAR THE BLOCK ARE READY FOR USE

FIG. 2—CONCRETE BLOCK TURNED OVER

Blocks for Jetties Made Without Molds

BY EDWIN A. BETHEL
MAJOR, CORPS OF ENGINEERS

For the major part of this article and for the illustrations, CONCRETE is indebted to *The Military Engineer*.

The existing project for the improvement of the Alabama River provides for securing a channel by open-channel work not less than 4 ft. deep at low water, from the mouth to Wetumpka, Ala., a distance of 322 miles. There is no adopted project width, though 200 ft. is taken as a minimum that must be maintained.

The work of improvement on this river consists mainly of the construction of spur dikes, or jetties, and snagging. The dikes are constructed by driving two rows of piles about 6 ft. apart (the piles in each row being about 8 ft. center to center), filling in with brush and weighting down the brush with stone or concrete blocks. A more recent type of jetty, which was used on nearly all work done during the past year, is one made entirely of the concrete blocks described in this article.

For considerable distances on the river, there is no rock except a soft soapstone which disintegrates when it is exposed on jetties and is, therefore, not suited for jetty construction. In order to avoid towing rock long distances on the river at considerable cost, a novel means of constructing "one-man" blocks of concrete has been developed. The idea was first suggested in 1915 by Major (now Colonel) Earl I. Brown, district engineer at the time.

In the river are various bars of sand and gravel which are several feet above the low-water level. In many places, this sand and gravel is, in its natural state, already mixed in proper proportions for making

concrete. Small holes spaced about $2\frac{1}{2}$ or 3 ft., center to center, are prepared in rows on the bar. A mixture of about $1\frac{1}{2}$ gals. of water (the exact amount varying with the moisture in the bar) and a cup of portland cement (8 lbs.) is then poured into each hole and mixed with sand and gravel, by shoveling, before the water has had time to soak into the ground. The result is a mushroom-shaped mass of concrete about 20 in. in diam and 12 in. thick. These blocks are allowed to remain in place about three days, when they are sufficiently hard to be turned over with a pick. They are then allowed to harden in this position for about three more days, when they can be loaded on wheelbarrows and placed on a barge. In an emergency this time allowed for setting can be somewhat reduced. While the blocks are hardening in one part of the bar, new blocks are being prepared in another part. The bar, with its rows of blocks, gives the general impression of a small farm.

The average sized rock gang is 14 men. Ordinarily 7 men are engaged in mixing the concrete and the other 7 in carrying water, mixing the cement and water, and pouring it into the holes. An average day's work for 14 men is 1,400 rocks, or the equal of about 107 tons. The size and number of gangs, of course, can be varied according to the quantity of blocks needed.

The blocks weigh from 150 to 155 lbs. each and, from their size and weight, are convenient for handling by one man. The cost per ton, on the bar, will average about \$2.25, with an additional cost of about 20c per ton to load on barges.

It will be noted that there is no strain on them; they are made solely for weighing down the brush or for the construction of all-rock jetties. Consequently, the quality of the concrete and variations in the proportions of sand and gravel are not as important as in other work. Besides being much cheaper than natural rock obtained from quarries down the river, these blocks possess the advantage of being uniform in size and are easily handled.

This uniformity in size and weight is a decided advantage, especially in the all-rock jetties recently constructed. These are built by placing successive courses



FIG. 3—JETTIES OR SPUR DIKES CONSTRUCTED OF CONCRETE BLOCK MADE WITHOUT MOLDS

by hand, each course consisting of rows of blocks; the width of the courses diminishing uniformly toward the top, in order to secure the desired slope. The top of the jetty is rounded off at a height of about 3 ft. above low water. One point of superiority of this type of jetty as compared with the pile and brush type, is that in the case of the latter, the tendency of the current to scour out around the end may threaten the safety of part of the jetty; in case of the concrete block jetty, any scouring would have no serious results, as the blocks at the end of the jetty would simply settle into any hole scoured out and a few more blocks placed on top would restore the jetty to its original condition.

While the concrete block jetties are more expensive in first cost than the brush and pile type, the fact that they are permanent and will require practically no repairs will probably make their ultimate cost less.

It is believed that many engineers, who have difficulty in obtaining rock, especially those engaged in river and harbor work, will find this method worth investigating.

It is thought that this method of making concrete block is limited in its application. In our particular case, lacking suitable rock for our jetties, (they should really be designated as spur dikes) we find it cheaper to make the concrete block from the sand and gravel bars in the river that become exposed during the low water season than to obtain rock from distant quarries on the river or else have it shipped in by rail, with the additional expense of transferring to barges and towing to the site.

It may be stated that the first requirement is that the sand and gravel must be found in its natural state already mixed in usable proportions. These river bars are scoured out to a certain extent during the high water season and then build up as the water falls until during the low water season the bars will be from 1 to 10 ft. above the water level, from 100 to 200 ft. wide and from 500 to 600 ft. long. As the river begins to fall and the velocity of the current slackens, large pieces of gravel are first deposited; the size of the gravel decreasing and the amount of sand increasing as you go downstream on the bar. Consequently the upper end of the bar contains too much gravel and the lower end too much sand. Usually the mixture is about right in the middle portion.

Another point to be considered is that the bar is saturated to a greater or less degree, owing to its proximity to the river, though the top of the bar of course will dry out. It is believed that this partial saturation is necessary to the success of the method. If the sand and gravel were very dry it is believed that the mixture of cement and water would soak into the ground too quickly to allow time to mix the concrete with shovels.

It is not believed that this method will permit the making of block much larger than those described, which weigh about 150 lbs. each.

No studies have been made as to the exact proportions of sand, gravel, and cement used. As stated the sand and gravel are found in about the right proportion in the middle of the bar. The amount of water is varied according to the degree of saturation in the bar. The amount of cement used is the least that experience has shown will do the work.

As stated above, while block were hardening in one part of the bar new block were being mixed in another part. It should be cited also that as soon as one batch of block is removed from the casting holes a new batch can be prepared, not in the same holes, but in the spaces between the holes, so that work can be carried on indefinitely on the same bar.



BUILT OF CONCRETE IN 1838

The Oldest Concrete House

(CONTRIBUTED)

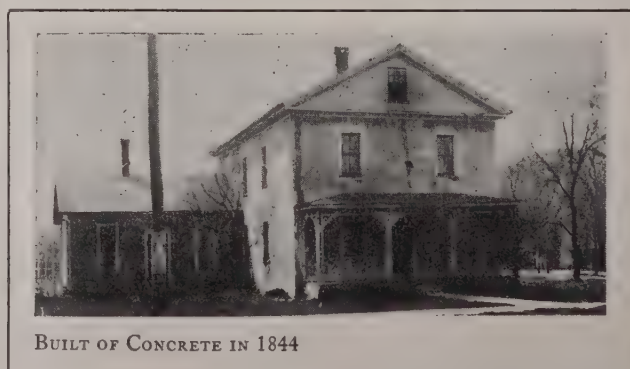
When the advertising department of the Portland Cement Association made the statement recently that "the concrete house has been with us since 1872" when the first house of this type on record was built, it stirred contractors and builders throughout the United States to try to locate a house even older than 52 years.

Someone in Minneapolis immediately reported a house of concrete masonry constructed 57 years ago. Then came Boston with a structure of 1856. Wisconsin now adds its contribution to the list of old concrete houses, and not only claims the oldest concrete house in America, but the oldest concrete community.

In 1838, Joseph Goodrich, steeped with a spirit of adventure, left Western New York, and with a shovel on his shoulder to test the soil, landed on July 16 of that year at what was then Prairie du Lac, Wis. The spade showing the soil to be fertile, and the location seeming ideal, he settled and founded the town now known as Milton.

A simple dwelling was erected to house the Goodrich family, which was later brought from New York State. Not only did this building serve as a dwelling, but as Milton's first store, post office and hotel. Located as it was at an intersection of the direct route between Madison and Chicago and the road between Janesville and Fort Atkinson, this wayside tavern soon became extremely popular and prompted Goodrich to erect a much larger building to serve the many travelers who wished to remain in Milton over night.

This new building, hexagonal in shape, with a wing extending along one side was Wisconsin's, and probably America's, first concrete hotel. Where the cement that went into this old building came from seems to be a mystery, and although the writer has spent consider-



BUILT OF CONCRETE IN 1844

able time interviewing men and women old enough to be his grandparents, none has been able to divulge this secret. The fact remains that the building was constructed much as concrete buildings of today are constructed, but with no reinforcement such as is found in the modern concrete building.

From W. J. Davis, a grandson of Joseph Goodrich, comes the most authentic details of the construction of the Milton House, as the old hotel was and is called today. Mr. Davis says "I am told that the forms used were very similar to those in use at the present time. These forms were about a foot high and the concrete was mixed and placed in the forms in the same manner as it is done today. After the batch of concrete was allowed to harden for one day, the forms were raised and another batch put in place. These forms extended entirely around the old hexagonal building. Then it was considered a good day's work to raise them, mix the concrete and place it in them."

In the center of the house a concrete chimney was erected, around which wound the stairs leading to the two upper stories. The walls of this chimney were approximately 12 in. thick, while the walls of the building proper were approximately 18 in. through.

Mr. Goodrich's idea of a concrete building seemed peculiar to the people living in and around Milton, and he was made the butt of many jokes concerning his new "pet". It is reported that, becoming angry one day, Mr. Goodrich handed a maul to one of his tormentors and told him that if he thought the building was unsound he might take the maul and strike the building with it if he wished, but that each blow would cost him five cents. This later was made a standing offer, but inspection of the old building fails to show any sign of damage incurred from this amusement.

Standing across the street from the Milton House is a dwelling which has been in continuous service since it was built by another New Yorker, Abram Allen in the year 1844. This is probably America's oldest concrete house and is worth today many times its original cost of construction.

Directly to the east of the Milton House is to be found an old blacksmith shop also erected in 1844. This today serves as a warehouse for a grocery store which occupies part of the old wing of the original Milton House. The rest of the wing has been taken over by the Davis Printing Co., a plant whose presses rumble day and night turning out work for large manufacturing concerns in nearby cities. Even the rumbling and jarring of presses that print the many thousands of pieces of literature turned out daily has failed to affect the old concrete building in any way, and while there are a few cracks in spots, it seems practically as solid as the day it was built.

Farther down the street is to be found another building built about 1851. This was intended originally for use as a wheat warehouse, but today the modern sign "Garage" adorns its front. This building, too, is in excellent shape and the old form marks can be plainly seen on the exterior walls.

Across the street from the house built by Abram Allen, and now occupied by G. L. Shumway, is another concrete house very similarly designed, constructed by Elijah Goodrich, an uncle of Joseph.

This building was erected in 1851, and is still known as the Polly Goodrich home. In the rear is a concrete barn which was built by Elijah Goodrich in 1850, for use as a wheat mill.

Down the street toward Milton Junction is still to be found another house of the same type. This was also built by Abram Allen and is still serving the purpose for which it was intended. A careful inspection of this house, as well as the others, shows them to be

in excellent state of preservation with scarcely a trace of disintegration.

A careful search through the records of the Wisconsin Historical Library and many hours spent in conversation with the older residents of Milton have failed to bring much light on the construction of these houses. Evidently at the time they were constructed, they were thought to be a fad or a passing flight of fancy on the part of the builders, and not thought worthy of great mention in the recorded history of Rock County, Wis., in which Milton is located.

This, as far as is known, is America's oldest Concrete Community.

First Concrete Skyscraper in Stockholm



FIG. 1—NORRA KUNGSTORNET UNDER CONSTRUCTION IN STOCKHOLM, SWEDEN

FIG. 2—THE COMPLETED STRUCTURE

From an article by Theo. B. Hoest, C. E. in *Ingenioeren*, translated by E. Lee Heidenreich.

Norra Kungstornet (The Northern Kingstower) is 17 stories high in addition to basement and a roof terrace and represents Sweden's first skyscraper. The building, with the exception of first floor stores, and the three upper floors for the beautiful restaurant Babel, is entirely arranged for offices. The skeleton is entirely of reinforced concrete, with face curtain walls supported from each story.

Fig. 1 shows the building under construction by the European method of scaffolding the entire structure, instead of supporting the scaffolding on the finished parts as the building rises, or using sliding forms. Fig. 2 shows the finished structure, a pleasing exterior of fine proportioning.

The foundations were rather difficult of design owing to adjacent buildings, which must be guarded against settling, the ground being clay.

The contractor as well as engineer, was the construction company, Contractor, of Stockholm, and the architect Sven Wallander.

A Southern Kingstower is now to be erected on the opposite corner.

The translator of these notes met Mr. Hans Krogh, managing director of Contractor in Sweden and showed him the modern American sliding forms, used in grain elevator and mill buildings, with the result that Contractor obtained plans of American grain elevators and samples of jacks such as are used here with the intention of introducing this method in Sweden.

Reinforced Concrete in Sea Water

BY HERLUF FORCHHAMMER

M. D. I. F. (DENMARK), M. AM. Soc. C. E. (U. S. A.)

From a paper presented at the International Cement Congress, London, April 22 and 23, 1924. Reprinted from the *Structural Engineer*, London.

The following remarks apply to the use of portland cement only, and are based on the author's own experience:

The time seems to be past when engineers seriously objected to the use of reinforced concrete in sea-water, although its application has not always been successful, but when this has been the case, serious faults in design or execution account for such results.

One essential condition for using not only reinforced concrete, but also mass concrete, in sea-water, is that the mixture should be sufficiently rich to form a dense and hard concrete; otherwise hollows will occur, and the concrete will deteriorate from the inside, the surface being many times enlarged.

Experience shows that mortar consisting of one volume of cement and two volumes of sand is satisfactory, and if the volume of the stone aggregate does not exceed the volume of the sand by more than 100% for mass concrete and 60-70% for reinforced concrete, the concrete will be dense and quite satisfactory, if mixed and deposited in a workmanlike manner with materials of first quality.

Some engineers specify even richer mixtures than this, but it does not seem to be of any great advantage, and is, in my opinion, only waste of money.

If the concrete used in submarine constructions is dense, as described above, deterioration can only take place from the surface, and will, therefore, be very slow, and soon stop entirely on account of the growth on the cement. Hence, it is a mistake when engineers specify a very great cover outside the steel reinforcement, particularly for piles in sea-water. A cover of 1 in. is, in my opinion, ample, and if a greater cover is applied the steel reinforcement will be too far away from the surface of the concrete to protect this from cracking, and cracks, of course, incur danger.

Regarding cracks generally, these are the main feature on which some engineers in earlier days condemned reinforced concrete in sea-water. For constructions above water, every engineer will have observed cracks which in good design with sufficient and correctly placed steel reinforcement, generally appear as hair cracks only. The question is, therefore, whether such cracks may be expected also in constructions in sea-water and thus expose the reinforcement rods to corrosion.

I trust that every expert nowadays realizes that this fear is not justified, as the conditions for concrete submerged in water are entirely different, and in this respect, far better, than for concrete in the air.

As is well known, concrete in the air will contract in time as the moisture dries out and cracks are the result—otherwise when the concrete is submerged in water, as the surrounding water prevents the drying out of the concrete, no contraction will take place, but rather a little expansion will occur, and this explains why hair cracks in reinforced concrete constructions submerged in water do not have any effect whatever on the durability of the construction as they will close themselves absolutely tight in a very short time. Of

course, it is necessary to design a construction so that no cracks of any consequence occur. The steel reinforcement must, therefore, be sufficiently and correctly placed as well where the theoretical analysis shows tension forces as where this is not the case, and the reinforcement rods must not be too far from the surface of the concrete where this is subjected to tension stresses; in other words, excessive cover must *not* be used.

During the war, when concrete ships were built for emergency, some important experiences about reinforced concrete in sea-water were gained. These ships proved to be very good ships so far as tightness, strength and permanence are concerned, the main objection against them, and the reason they are unlikely to be built any more being their heavy weight.

For concrete ship designers the principal question therefore was to reduce the weight, and in doing so the percentage of steel in concrete ships is very much higher than in any other construction previously used, and the cover is generally very small; but nevertheless concrete ships have proved to be permanent and tight.

SUMMARY

When reinforced concrete is used in sea water the following requirements are essential:

1. The materials used must be of the very best quality.
2. The proportion of cement to sand and of sand to stone is not to be less than 1 volume of cement to 2 volumes of sand to 3, or at the most $3\frac{1}{2}$, volumes of stone.
3. The cover outside the tension rods is not to be less than $\frac{3}{4}$ in. and not more than $1\frac{1}{2}$ in.
4. The sectional area of the steel is not to be less than 1% of the concrete section.
5. The design must be carried out by experts well experienced in this particular class of work, and the steel reinforcement is not to be placed only where tension is sure to take place, but also where this is not the case.
6. The work must be carried out in a workmanlike manner by specialists well experienced in this class of work.

The Builders' Code

The code of ethics adopted by the members of the Associated Building Contractors of Illinois is as follows:

The Builder considers his vocation worthy of respect and adulation as affording him distinct opportunity to serve society.

The Builder desires to improve himself, increase his efficiency and enlarge his service, and by so doing, he expects to profit through and by such service.

The Builder realizes that he is a business man and ambitious to succeed, but that, first he must be ethical and wish no success that is not founded on justice and morality.

The Builder holds that he must exchange his product, his labor, his service and his ideas for profit. He wants that profit to be legitimate and ethical and desires all parties in the exchange benefited.

The Builder wants to be an example to his brother builders and uses his best efforts to elevate the standards of his vocation, and conduct his affairs that others may find it wise, profitable and conducive to happiness.

The Builder wants to conduct his business so as to render perfect service, superior to his competitors, and, when in doubt, give service beyond the strict measure of obligation.

The Builder believes in the Golden Rule: "All things, whatsoever ye would that men should do unto you, do ye even so unto them."

The Builder contends that society best holds together, when equal opportunity is accorded all men.

The Quest for Better Concrete

By THADDEUS MERRIMAN

CHIEF ENGINEER, BOARD OF WATER SUPPLY, CITY OF NEW YORK

From *Engineering News Record*

Among the many materials used in the world of engineering construction none is of more importance or of greater utility than portland cement, which has come to be the basis of nearly all concrete made with calcareous binders. Our knowledge regarding the qualities and characteristics of cement, however, is not as far advanced as is that relating to others of the manufactured materials which enter into the numerous structures designed and built under engineering supervision. The reason for this condition is apparently to be found in the extremely complex nature of the material itself. Chemical analysis does not serve to distinguish or identify the nature of the several compounds of which the cement is composed. Microscopic examination has been helpful and has done much toward advancing the sum total of information on this important question. Many physical tests of various kinds have been suggested and countless thousands of briquets and cylinders have been broken but the mystery as to what occurs in the process of "setting" has never been solved. No explanation which fits all of the observed facts relating to this phenomenon has yet been advanced.

The search for a better concrete, as evidenced by most of the recent investigations, seems to have for its object the securing of a more uniform quality with respect to careful selection, proportioning and mixing of the constituents and with the end in view of securing a maximum of strength for a minimum of cost. Strength, apparently, is the only criterion by which quality and durability are judged. But what relation is there as between the strength of concrete at 28 days and its ultimate durability?

Nearly all concrete is good when first placed. In many situations it continues good and is possessed of a high degree of durability and permanence. In other situations, however, disintegration sooner or later begins and progressively continues. In many such cases the principal contributing cause is probably the porous nature of the concrete while in a fair percentage of cases the causes of disintegration are obscure and cannot be ascribed to any particular condition.

A portion, at least, of the troubles which sometimes occur arises from the fact that, quite unconsciously, we have come to consider cement as a universal material suitable for use everywhere and under all conditions. There is only one standard grade of cement but many different qualities of steel are to be had for the asking, and each one of them fills a particular need. So, also, should it be with cement. The general use of one grade of material for all purposes does not tend toward true and ultimate economy.

CEMENTS NOT ALIKE

The art of mixing and proportioning concrete has been advanced to such an extent that it is now possible, by considering the sizes, the relative fineness, and the proportions of the aggregates, and by controlling the mixing water, to "design" a concrete mixture so as to secure, for a given cement content, a maximum of strength and density, as these terms are commonly

understood. These studies generally, however, take no account of the differences which exist between different types of cement, and so it happens that results obtained with one type cannot be duplicated when another is used. The assumption tacitly made by many investigators, that all cement which passes the requirements of the standard specification is of equal quality, is untenable. Some types of cement will produce concrete of greater strength than will others. Certain types are less sensitive to an excess of mixing water; others will produce a high early strength; still others will not give a high strength until after the lapse of months. As has long been recognized, the age of the cement is also a vital factor in affecting the activity and integrity of its constituent components. Can it, then, be fairly assumed that all types of cement produce concrete of equal permanence?

The very best mixture of the finest obtainable aggregates is of itself useless as concrete. The material which binds the mass together is the cement and no amount of care in proportioning the sand, the stone and the water and in making the concrete according to current good practice, can overcome a deficiency which may exist in that ingredient. The search for a better and a more uniform concrete, necessary for many purposes, seems to have arrived at the stage which indicates that the next logical step is an examination of the cement itself.

When the field of study and endeavor in matters relating to calcareous cements is reviewed, the one outstanding feature to be observed is that these investigations have proceeded on the principle of direct observation under limited conditions and in restricted combination. Little, if any, effort in reported results has been put forth along the line of indirect and collateral analysis, a method which has proved to be of the greatest use in practically all those lines of scientific endeavor in which great and substantial progress has been recorded. Similar methods of research must be employed on the problem of cement, else the cause of concrete will fail of substantial progress.

WHY NOT A NEAT TENSILE TEST

In 1917 the "Standard Specifications and Tests for Portland Cement" of the American Society for Testing Materials were revised and the requirement of a test for the tensile strength of neat cement briquets was eliminated. This test was the only physical test of the cement *per se* which the specifications contained, because the 1:3 mortar test briquet discloses not the strength of the cement but rather its ability to adhere to the grains of the Ottawa sand with which the specimen is made. This statement will become clear if the broken end of any 1:3 briquet is examined and it is seen that about 45% of the area of fracture consists of clear sand grains from which the cement has cleanly parted while another 45% consists of the cavities left by the sand grains of the other half of the briquet. This test, evidently, is a measure of the adhesive quality of the cement and is by no means an index of its inherent tensile strength.

The tensile test of neat cement when mixed to the standard consistency called for by the specifications prior to 1917 was abandoned for a variety of arguments, among which the following may be cited:

1. The test is unnecessary. It discloses nothing which the sand briquet does not show.
2. Tensile tests, at best, are not of great utility. Comparative tests are of more value. The usual forces which concrete and mortar are called upon to resist are those of compression and shear.
3. The test is not a fair one. As the strength

of the specimen increases, it becomes more and more brittle, with the result that the stresses set up by the grips of the testing machine become so complicated as to render the results of doubtful value. Thus, the retrogression in strength from 7 to 28 days often noted is not due to any inherent quality of the cement but is the result of the rigidity incident to increased strength.

4. The results as between the tests on the neat and the sand briquets are often conflicting and not to be reconciled.

It has already been shown that the first of these arguments was far from being sound. As to the second, it only seems necessary to point out that whenever concrete or mortar fails under stress the evidence nearly always indicates a failure in tension or in shear. It seems extremely doubtful that any material can fail under a compressive force unless its tensile and shearing resistances are first overcome. In general, if all other conditions are the same that material which shows the highest tensile strength will develop the greatest resistance to compressive forces. In the case of concrete and mortar, however, it seems as though the reverse were often true. This point will be discussed in detail at a later time.

The third argument, as above stated, while of itself plausible enough, does not seem to be sufficiently convincing by itself to warrant the exclusion of a tensile test on the cement. The fourth argument was based on the facts as observed but not on a true understanding of their meaning because it failed to take account of the essential differences in the fundamental nature of the tests themselves.

The neat test was an index of the quality of the cement when mixed to the standard consistency with about 20 to 25% of water. On the other hand, the sand briquet test was made by mixing three parts by weight of Ottawa sand with one of cement and with an amount of water which averaged from 39 to 43% of the weight of the contained cement. In view of the known effect of water on cement it could not be expected that the results of these two tests would always be concordant. Some types of cement will take care of greater quantities of water than will others—that is to say, all cements do not behave in the same manner when mixed with equal quantities of water. These two tests, moreover, are of a different nature; the cement particles in the neat briquet lie very much closer together than they do in the sand specimens. The first of these tests is a measure of the adherence between the cement particles; the second is an index of cohesion between cement and sand grains.

The foregoing briefly outlines certain fundamental considerations that need to be given extended study in connection with the development of tests which will more truly disclose the quality of cement than do those now available. In setting forth these considerations no criticism of portland cement or of the present specification is intended. The important thing is that our knowledge regarding cement, its qualities and its characteristics, should be broadened to the greatest possible extent. The omission of the neat test has served to focus attention on a phase of the subject which might otherwise have escaped notice for many years and has thus come to serve a most useful purpose.

WHAT SHOULD BE STUDIED

A complete and comprehensive outline looking toward the determination of quality and the classification of different types of cement will include at least some of the following:

1. Permissible variations in chemical composition and characteristics, with limitations on certain of the ingredients.
2. Requirements as to fineness of grinding, both before and after burning.
3. Tests for the tensile and compressive strength both with and without sand.
4. Requirements as to behavior in the presence of varying quantities of water.
5. A determination of the amount of each of the cementing constituents which may be present.
6. Requirements as to the speed and the order in which the hydration of the several constituents is completed.
7. A limitation as to the permissible change in quality resulting from age.
8. A requirement for soundness and constancy of volume.
9. A test for the completeness and uniformity with which the clinker has been burned.
10. A test for the time of "setting."
11. A requirement as to uniformity of mixture of the raw materials before burning.
12. A limitation as to permissible admixtures.
13. A limitation as to the use of the water for the quenching of the clinker.

Before progress toward a better understanding of the factors which govern the inquiry can be made, it is advisable to list tentatively the characteristics of what may be termed the ideal cement. By so doing the desired goal will be kept clearly in view and, at the same time, the scope and character of the examinations and studies requisite to the solution of the problem will, in some measure, be disclosed. These characteristics may, in general, be stated as follows:

1. A maximum strength at a minimum of cost.
2. A maximum of density, durability and permanence.
3. A minimum of solubility both in and out of water.
4. A maximum of tensile strength under all conditions and in all directions within the mass.
5. A maximum of stability as against the development of internal stresses due to internal change of form.
6. A minimum of deterioration during storage, and
7. Within reasonably wide limits, a minimum of susceptibility to variations in the quantity of mixing water.

At a later time there will be outlined the result of certain investigations and observations which, for several years, have been in progress in the laboratory of the Board of Water Supply, New York City. These investigations have been carried on, under the direction of the writer, by L. B. Stebbins, assistant to the chief engineer. It is hoped that the indications of these researches will be of value to all who are interested in the study of cement and that they will serve the purpose of pointing out a few of the many possible directions from which the problem, as a whole, can be approached.

A New Garage Book

The Portland Cement Association has issued a new booklet "Concrete Garages." It contains many designs of concrete block garages covered with portland cement stucco.



THE STOCK PILE
OF THE LARGEST
BRICK PLANT

The Largest Concrete Brick Plant in the World

By CLOYD M. CHAPMAN
ENGINEERING SPECIALIST, N. Y. C.

Concrete brick have undoubtedly come to stay. The widespread distribution of the raw materials, their availability at the point of consumption as contrasted with more localized clay deposits, often at a considerable distance from the more active markets, offer advantages that are attractive in these days of high transportation costs. Add to these the greater ease and lower cost of handling sand either by dredge or bucket, and the low labor cost and almost negligible fuel cost of operating a concrete brick plant, and the result is a convincing argument for the soundness and prosperity of the concrete brick industry.

Concrete brick are not only cheaper to manufacture than common clay brick, but they are better brick in every way. Their truer lines, uniform size and shape make them equal in these respects to the finest repressed clay brick. The fact that they make a decidedly stronger wall, and that they develop a markedly higher percentage of their individual strengths when laid in a wall then is the case with clay brick, is bound to make them a popular structural unit.

Concrete brick have been manufactured in this country for at least 30 years. Though the industry is not new it has never attained flourishing proportions due in part to the natural tendency to continue the use of the age-old clay brick. Within the past few years the ever increasing general use of concrete, together with a scarcity of clay brick and the high price to which they have soared, have led to a greater recognition of the value of concrete for building units.

But to make high quality concrete brick at a low price necessitates a plant wherein manual labor is used to a minimum extent, where the equipment is perfectly adapted to the work it must perform, where breakdowns and stoppages are infrequent, and the normal output can be counted on day after day. In a young and rapidly growing industry these plant conditions are of gradual development. Quantity production of a quality product at the lowest possible cost means a plant that does not falter and hesitate or shut down every little while. The cement brick industry has been conducted largely by numerous small plants. A plant having an output of 50,000 brick a day or even

25,000 has, in the past, been considered quite a plant. The business has been "small business." Now it is entering the field of "big business." Plants making 150,000 brick a day and keeping it up are producing a half million dollars worth of brick a year. That is not "small business."

Concrete brick are now recognized and accepted by the building departments of many cities including most of the larger ones. The American Society of Testing Materials, the American Concrete Institute, the Bureau of Standards, and the Underwriters' Laboratories, recognizing the growing importance of this industry, are all—individually and in collaboration—devoting much time and energy to its study, in carrying on tests and investigations, and in the development of standard specifications. As a result, the past two years have seen the erection and successful operation of, to the best of our knowledge, the two largest concrete brick plants in the world—the smaller at Baltimore and the newer and larger at Philadelphia. These are the first of their kind in this country to produce successfully on such a large scale, the Baltimore plant having a daily capacity of 110,000 and that at Philadelphia of 150,000 per day.

The manufacturing-time element gives further advantage of this product over clay brick. Concrete brick can be ready for the market in 7 days, allowing 6 days for curing in the yard, after 24 hours in steam rooms. This is probably not to be recommended as the best practice, but when the demand is strong and the reserve supply low it is an advantage not to be overlooked.

Absorption of moisture, which is dependent on the quality and grading of sand, on the use of integral waterproofing, and on various other factors in the manufacturing process, can be controlled over the permissible range of percentages to suit requirements.

The color of common brick, as distinguished from face brick, is usually—depending upon the sand—a grey close to that of the cement used. Owing to the fair constancy in the color of cement, and by the use of sand from a single source, the color of the brick is usually nearly uniform. This eliminates any need for

grading of the brick as is necessary in the clay brick industry. For particular requirements, colors, other than this grey, may be obtained through the use of selected sands, where obtainable, having degrees of color, or by facing with mineral colors or with colored stones and slates.

The weight of a concrete brick is comparable to that of a clay brick of equal size. The only variation in weight is that due to density, which is controllable in manufacture. The use of steel molds and the character of the curing process prevents any possibility of variation either in shape or size. Compare these features to the warped and twisted shapes, the curved and irregular surfaces, and the variable sizes which are often obtained in clay brick. Because of these uniformities the concrete brick wall can more easily be laid true. The resulting uniformity and accuracy of mortar joints, together with the greater effectiveness of the bond which exists between cement mortar and concrete brick go to produce a wall having 50% to over 100% greater strength than a clay brick wall when using concrete and clay brick of the same individual strength. Strength tests have been made by various authoritative laboratories, among them the Bureau of Standards, Columbia University, and the Pittsburgh Testing Laboratories, all giving conclusive evidence of these superior qualities of concrete brick.

In fire tests of great severity recently conducted by the Bureau of Standards and in the case of actual fires concrete brick have continued to show their value as building units of first importance. Additional tests are now under way by both the Bureau of Standards and the Underwriters' Laboratories.

Concrete brick are slightly harder than the common run of clay brick, though not too hard to be split with the trowel. This feature alone means considerable economy for the consumer, as the breakage due to handling and dumping is reduced greatly and the necessity for heavy overbuying thereby eliminated.

The plant of the Pennsylvania Brick & Tile Co., at Philadelphia, is quite ideally located on the Delaware River waterfront at the foot of Westmoreland Street, within about an eight mile trucking distance of the furthest outskirts of the city. The plant consists of a main building of the steel sectional type, housing the cement storage, the material distributing machinery and the mixing and tamping equipment; a set of seven curing rooms adjacent to one end of the main building; a boiler house; a brick storage yard to care for 4,500,000 brick; a sand storage bin of 4500 yards capacity, located between the main building and the dock; a sand unloading derrick on the dock; and sand conveying belts from dock to bin, and from bin to manufacturing building.

A mast and gaff derrick, swinging a $1\frac{1}{4}$ -yard clam-shell bucket and operated by a double tandem drum electric hoist, unloads the sand from the barges as received and delivers it through a loading hopper to a 300-ft., 16-in. rubber covered belt conveyor to the storage bin. This belt runs level along the dock for a short distance and then rises to enter the top of the storage bin at a height of about 50 ft. Walkways are provided on both sides of the elevated portion of the conveyor. A movable tripper over the bin facilitates dumping the sand at any desired point in the bin. Two to three barge loads are handled per week.

The sand storage bin is more or less of the usual wooden construction, supported on concrete-capped piles and covered with a steel frame monitor type roof. The bin is 62 ft. long, 42 ft. wide and 30 ft. high, exclusive of the roof, which runs to a height of 25 ft. over the top of the bin. Midway under the bin and



FIG. 1—BATTERY OF SPECIALLY BUILT MINERS

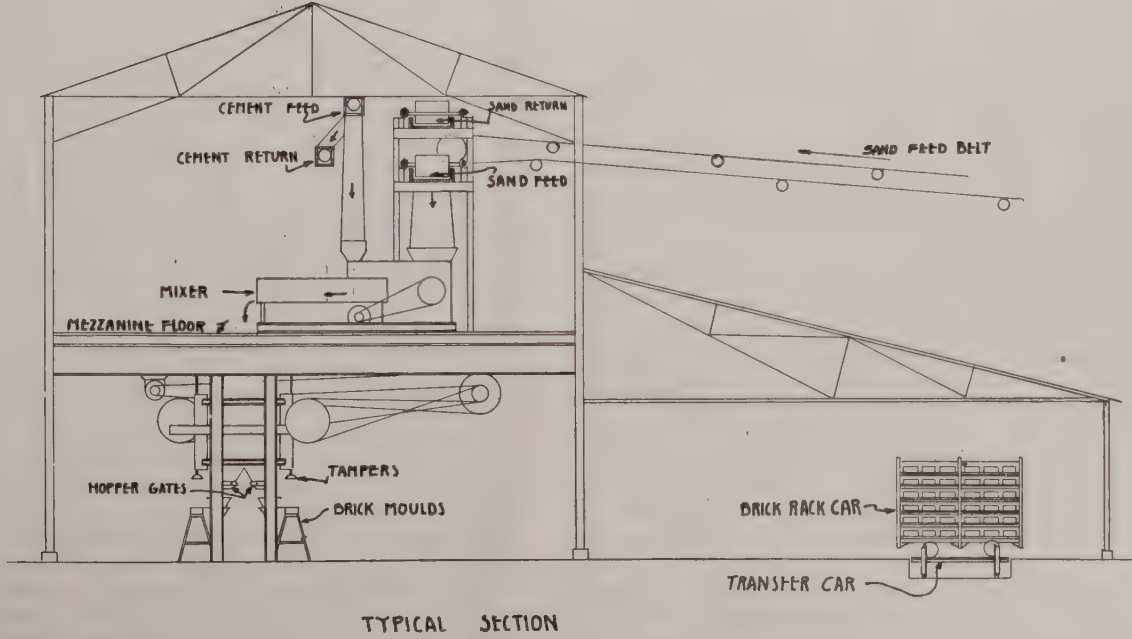
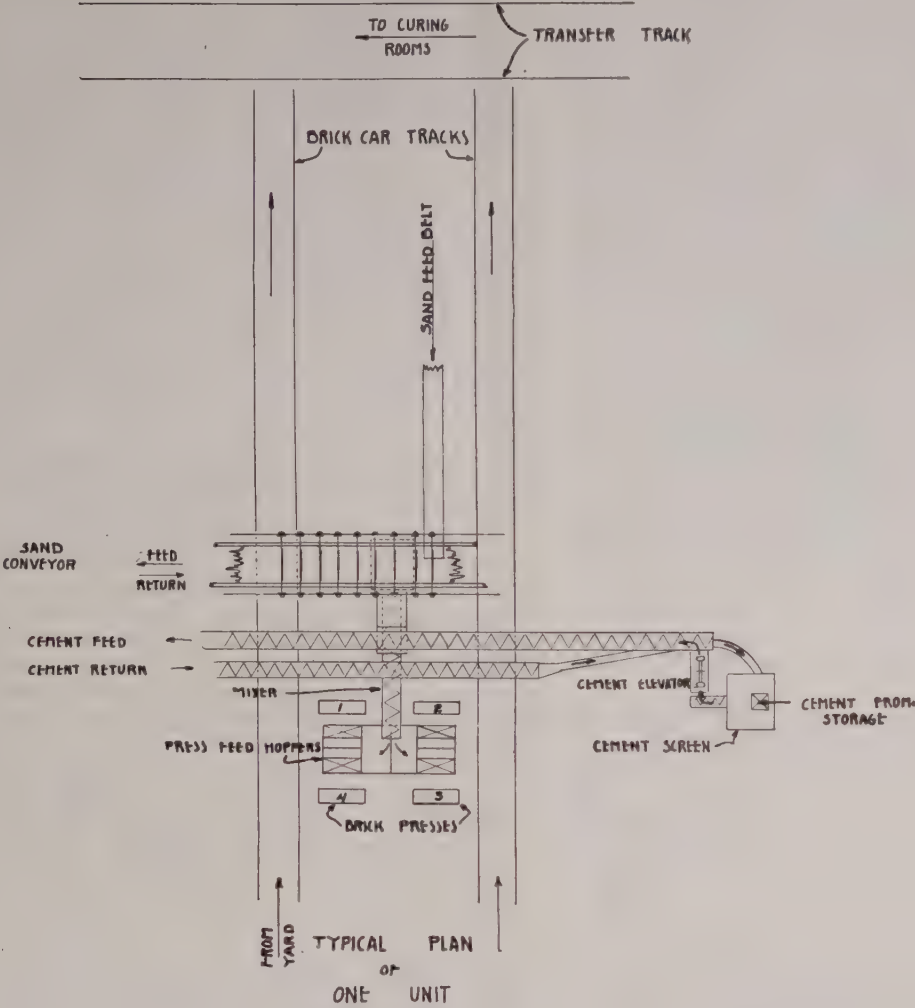


FIG. 2—BRICK MACHINES AND CARS

running lengthwise with it is a concrete tunnel for the belt conveying the sand to the manufacturing building. This is fully lighted and of sufficient size for the comfort of the gate operator. Sand is drawn from the bottom of the bin through ten opposed inclined gateways in each sidewall of the tunnel. In this way the maximum amount of sand can be delivered by gravity from the bin to a 14 in. rubber covered belt conveyor some 334 ft. long. The sand is fed to the belt by a movable hopper loader running on track laid each side of the belt. This loader is provided with a gate to regulate the quantity of sand which the belt can carry away. This insures a uniform stream of sand being delivered to the distributing system. Starting immediately at the open end of the tunnel this conveyor rises on a 20° inclination to cross a series of railway tracks on a steel bridge and thence into the building where it delivers directly into the lower trough of a roller flight conveyor. (Link-Belt conveyors throughout.)

The success of this type of plant is very largely made possible by smooth continuity of operation, which is facilitated by continuous mixing of the concrete. This, in turn, means uninterrupted distribution of sand and cement to the mixers. For the sand this is very satisfactorily accomplished through the use of a heavy type of roller flight conveyor placed over the mixers. This conveyor is of very rugged design, built for heavy continuous duty, long life, and low maintenance cost. It consists of steel flight plates about 30 in. long suspended at near their mid-point of each

FIGS. 3 AND 4—LAYOUT
OF PENNSYLVANIA
BRICK & TILE CO.
PLANT IN PHILADELPHIA



end on a heavy bar chain, which is in turn carried on flanged wheels or rollers, running on steel tracks. The flights, extending both below and above the chain, operate through wooden troughs along both the lower and upper, or return, runs. This is indicated in the cross section of the diagrammatic sketch. The sand, received from the belt bringing it from the bin, called the "sand feed belt" on the drawing, is carried to the mixers on the lower trough of the conveyor and delivered through gates in the bottom of the conveyor trough and thence through fully enclosed chutes to the mixer hoppers. As the hopper of the first machine fills up, the sand carries on over this gate to number two hopper, and so on until all are filled. Any surplus sand is carried to the head end of the flight conveyor and lifted on the flights which operate through a metal boot to prevent spilling back. As the flights move up over the end for return, this surplus sand slides off into the upper trough, is carried along by the other half of the double flights, and spilled back again to the lower trough at a point between the first mixer and the sand feed belt, thus completing the circuit.

It is to be understood that the plan view, as shown in the sketch, includes only one unit of presses and their adjacent tracks. As shown, this is the first unit numbered from the cement elevator. The sand feed belt—coming from the bin—comes to the sand flight conveyor at about the point shown. This belt would not be shown, of course, in a typical plan of any other than this first unit.

The entire sand distributing system, including the belt conveyor carrying sand to the bin, is designed not only to deliver continuously, but also to carry far in excess of the quantity of material that can be required of it. The flight conveyor has a normal rated capacity well above the quantity of sand that the four mixers can possibly take. And so too, the belt conveyor, bringing sand to the flight conveyor, has in turn a capacity considerably above that of the latter. In order to avoid overloading the flight conveyor in case of a sudden shutdown, a fool-proof system of push button motor controls has been installed. By this system the belt conveyor cannot be started unless the flight conveyor is running, nor can the flight conveyor be stopped without automatically stopping the belt conveyor.

Cement, in bags, is brought to the plant by rail, and unloaded by gravity roller conveyor into the storage room in one end of the building. For use it is dumped from bags through a screen into the boot of a bucket elevator located in the cement storage room and delivered to the mixers by a screw conveyor. The trough of this conveyor also has gates at each mixer, the cement being fed to the mixer hoppers through canvas bags hanging from the gates to the hoppers. This insures that all mixers are automatically supplied with a constant flow of cement. The cement distributing system, like that of the sand, has a capacity well over the quantity of cement required by the mixers. The surplus material is chuted from the end of the distributing conveyor to a return screw, carried back to near the starting point, and chuted again through a closed pipe to the boot of the elevator, closing the circuit of the cement. The cement screen, the elevator and the two cement screws are shown in plan on the sketch. Reference to the cross-sectional view will indicate the relative position of the cement feed and return screws, as well as the cement feeder bags between feed screw and mixer. The arrows indicate direction of flow of material. The entire cement system is operated, all from one motor, as a single unit. The plant uses about seven cars of cement per week when operating to full capacity. It might be mentioned here that the empty

cement bags are very thoroughly cleaned by a specially designed and ruggedly built bag cleaner, and the salvaged cement automatically returned to the elevator boot by a small screw conveyor receiving cement from the hopper bottom of the cleaner.

The plant is equipped with four direct motor driven continuous mixers of the pug mill type, located on a mezzanine floor over the brick machines (special Kent continuous mixers). These machines are shown on both the plan and sectional views of the sketch, located just under the sand and screw conveyors. Attention is called to the position of the mixer so that the mixed material falls directly from the mixer discharge into the hoppers, mentioned below. These mixers are designed to give a thorough mix, and with a view to ruggedness to withstand unusually heavy duty with a minimum of maintainance. The capacity of these mixers is more than sufficient to supply the demand of the four tamping machines working under conditions of maximum production. As outlined above, sand and cement are continuously fed to the mixer which in turn automatically controls the proportioning by reciprocating feeder plates.

Water for the mix is supplied from an overhead tank which is kept filled to a constant level by means of a motor driven centrifugal pump and an overflow pipe to the pump suction. This insures a constant gravity head and permits easy regulation of the supply through a control valve at each mixer. Materials for accelerating the hardening of the brick are added through solution in the mixing water previous to pumping to the overhead tank.

Brick are manufactured with sixteen face-down tamping machines (Anchor automatic) grouped in units of four. These are of an improved design, and like the mixers, built to withstand the heavy duty imposed upon them. These machines are belt driven, each group served by a separate motor driven line shaft. One mixer serves each group by means of two two-way hoppers, and a dividing gate at the discharge of the mixer regulates the quantity of mix to each hopper. Each tamper, making ten brick at a time, has a normal rated capacity of about 10,000 for a nine hour day, though this figure is constantly exceeded in production. Material is fed to a pan from the hopper by means of a rocking gate on the hopper, controlled by foot pedal. The filled pan is pulled forward by the operator to a position over the molds, and the material tamped in the molds by the machine. The plan view of the sketch shows the relative position of four presses composing one group or unit, with the hoppers suspended between them. In the sectional view are shown both the press molds, and their tampers with drive therefor. Between the tampers is shown one of the two-way hoppers with gates for feeding to the pans. The pans are partially shown under the hopper gates and just behind the press molds. The ten brick, as a single unit, are turned out of the molds by hand onto galvanized sheet metal pallets, and are loaded, with pallets, on rack cars running on tracks on both sides of each group of tampers. Each rack car has a capacity of 560 brick. As loaded they are moved to the rear of the building and carried by a hand operated double transfer car to one end of the curing rooms. A loaded car placed on the transfer is shown on the sectional view of the sketch.

The curing rooms are adjacent to one end of the main building opposite to that of the cement storage. They are open ended rooms 80 ft. long, the walls built of brick—the plant's own product—and the roof of wood construction covered with a tar and paper waterproofing. The ends are closed with canvas curtains which may be rolled up to place or remove cars. There

are seven rooms and four tracks in each room, providing space for about 300 cars or over 170,000 brick. As each room is filled the curtains are dropped and steam is admitted, exhausting into the room through a series of perforated pipes. Additional moisture is supplied, when required, by a system of water sprays. Steam consumption is not large and hence the item of fuel cost is small. A plant of this size requires approximately one ton of coal per day. The brick are allowed to remain in the curing rooms for 24 hours.

At the end of the curing period cars are run out from the curing rooms at the end opposite to their entry, onto a power driven triple transfer car which delivers them to the various yard tracks. Unloaded, the cars, bearing empty pallets, are returned to the tracks leading into the main building and to the brick machines, ready for the next round.

With few exceptions only common labor is employed. The 60 men employed in the plant are distributed as follows:

Unloading and feeding sand.....	2
Unloading and feeding cement.....	3
Operating mixers.....	2
Operating brick presses.....	14

Operating tile presses.....	4
Transfer men (green brick).....	2
Transfer men (cured brick).....	3
Unloading rack cars.....	9
Loading trucks for shipment.....	12
Mechanic and helpers.....	3
Firemen.....	2
Superintendents.....	4

The brick press operators are paid on a piece-work basis with a bonus for production over 8000 per day. All other labor is placed on an hourly basis.

The outstanding features of this design are:

1. Continuity of operation.
2. The closed circuit distributing systems for raw materials.
3. Distributing systems of spare capacity.
4. The unit grouping of brick making machines.
5. Abundance of storage space for sand, cement and brick.
6. Minimum of labor without expensive complicated automatic machinery.

The plant was designed and built by the Cemprod Engineering & Construction Co., Inc., of New York, with Cloyd M. Chapman acting as Consulting Engineer.

Aluminous Cement ("Ciment Fondu") Pure or Mixed (Sand Cement)

BY PROF. A. PARIS
UNIVERSITY OF LAUSANNE

From a paper presented at the International Cement Congress, London, April 22 and 23, 1924. Reprinted from the *Structural Engineer*, London.

Since the year 1920 the Compagnie de la Fonte électrique, at Bex, has been manufacturing an aluminous cement, which it has placed on the market under the name of Electro-Cement. This article, produced in accordance with the formulae of the French chemist Bied, has been subjected in Switzerland to various interesting uses, advantage being taken of its rapid and high mechanical resistance, with two or three days' hardening, and its chemical unalterability in the presence of selenitic waters.

Without stopping to deal with tests in the manufacturing of drains for corrosive water territory, now being carried out, we will confine ourselves here particularly to two jobs, one on mountainous ground and the other on marsh ground, namely:

(1) Repairs to the Magnacun Tunnel, Rhaetic Railways system, Les Grisons.

(2) Construction in reinforced concrete for the floor and pile-work, at the Villeneuve Gasometer, for the Société du Gaz de la Plaine du Rhône, Vevey-Leysin.

1. The masonry of the Magnacun Tunnel, on the Bevers-Schuls line (Engadine) has an eventful history. Built between 1909 and 1913, the gallery has a length of 1909 metres, of which 368 metres, Km. 134,918 to Km. 135,286, are in anhydrite schists ("Bundner Schiefer"): The intense pressures were calculated to assist in the chemical destruction of the mortars. Immediate precautions were taken by replacing the usual section, rectangular piers, by an ovoid section having

a thickness of 90 centimetres at the key by 1.20 metre at the haunches or spandrels. Some distortions being nevertheless disclosed a 5 m. radius vaulted floor was built under rail track, supporting the evacuation channel which was moreover soon choked by abundant mineral deposits; the floor and the foundations of the piers were thus immersed in a pool of sulfatous water, which quickly caused the destruction of the portland cement hardened on the spot, involving the cracking, more or less horizontal, of the masonry; the floor rose slowly between kilometres 135,066 and 135,076, the swelling being as much as 40.3 centimetres; simultaneously the tunnel narrowed about 25.5 centimetres, shortening its outline and causing bursting of the masonry, attaining a depth of 20 cm., particularly at the vault, of 2.40 m. internal radius.

This critical situation induced the company to carry out some preliminary consolidation work in 1916, over a length of 28 metres, from Km. 135,015 to Km. 135,043. Having found, as moreover pointed out by Feret and Gary, that the very compact portland cement concretes were scarcely dangerously attacked, if they had had the time to completely harden out of reach of the gypseous water, the floor sector was built on the spot, in portland pugged masonry, the acid water being carefully evacuated for months by pumping; the result was good, but the precautions had been burdensome; five years later, when the floor had to be lengthened, the piles were visibly intact and undamaged.

In November, 1921, the work was recommenced by ashlar work in granite or blocks of concrete cast beforehand, but at the points where the intense pressure required rapid resistance, and where the selenitic water

showed itself dangerous—that is to say, over a total length of 190 metres—it was preferred to build the floor and the foundations of the piers by using aluminous electro cement mortar. The ashlar work of the floor and the foundations of the piers was prepared outside the tunnel, partly in granite and partly in concrete of well hardened portland cement, then placed in position and well pugged and protected, in virtue of the selenitic springs, by a layer of aluminous cement.

The acid springs, characteristic of this sector, showed the following contents in mineral salts, according to the samplings and detailed analysis of the company and the revision by Professor R. Mellet:

MAGNACUN TUNNEL WATERS					
Content in Mineral Salts					
Samplings.....	Pier	Channel	Channel	Gate	
Kilometre 135 +	0.042	0.110	0.515	0.965	
	I	II	III	IV	
Sulfate magnesium $MgSO_4$	0.0250	0.1255	0.5720	0.5425	gr./lit.
" calcium $CaSO_4$	0.2544	0.9574	0.7290	0.7843	
" sodium Na_2SO_4	—	0.1450	0.2622	—	
Carbonate calcium $CaCO_3$	0.3722	—	—	0.0145	"
Chlorides and carbonates (alkaline).....	0.1344	0.0941	0.1479	0.1577	"
Calculated residue.....	0.7860	1.3220	1.7111	1.4990	"

According to the plan of reconstruction, the samplings I and II are the only ones immediately touching the repairs zone; the second of these appreciably exceeds the gramme of residue per litre, already showing exceptional acidity; its content in magnesia $Mg. O$ reaches 0.0251 gramme per litre; it even reaches 0.114 gramme at the channel, Km. 135,515, being then at the level of the most active waters indicated by Nitzsche (Emperger V., page 39, Dr. R. Grün); special precautions had therefore to be taken. The use of the aluminous electro cement met the case, for the railway company's report states: "The short time required for hardening, about eight hours, and the extraordinary resistances, obtained after a few days, suited this cement very well to the particular case. If the unalterability against the action of the selenitic waters is verified, which cannot be reliably proved for some years, this would be an additional and invaluable advantage of this new bond (the electro aluminous cement)."

II. The second job, the 20 metres diameter platform of the Villeneuve Gasometer, constructed at the commencement of 1923, is composed of a floor in reinforced concrete, placed on unstable ground (fluent alluvions of the delta of the Rhone), allowing the piles to penetrate, without much resistance, to a depth of ten metres. The level of supersaturation in the subsoil may sink nearly two metres under the platform, and can rise again almost to the level of the neighboring soil, at high water. Its mineralization is given as follows by the Cantonal Laboratory of Lausanne:

Sulfate calcium $CaSO_4$	0.3110	grammes per litre
Carbonate calcium $CaCO_3$	0.4500	"
Chlorides.....	0.0050	"
Balance, by difference.....	0.0015	"
Calculated residue.....	0.7675	"

The constantly immersed part of the piles was made in wood; but the sector between two sheets of water had to be protected against rotting from acid action; this was, of course, less to be feared than in the case of the Magnacun Tunnel, for the water, of a less sulfated nature, and containing no magnesia, was also slower in movement; however, some serious accidents which occurred a few kilometres from there in the basins of the Gryonne and Avançon, counselled prudence. If the strains to be provided for were slight, great importance was attached to the compactness of the concrete; the use of a rich concrete became very burdensome in pure cement; we therefore adopted sand-cement, proportion 40% in weight of aluminous clinker and 60% siliceous sand.

The piles of 30 centimetres circumscribed diameter, were sunk without difficulty after hardening, by driving under a sand mattress.

The tests made during these two jobs, show various aspects of the question of the use of electro aluminous cement. Certain jobs utilize preferably its quick time high resistance, thus getting over the question of price which is still very high, in the case of this remarkable bond; other jobs rather require the quality of chemical resistance to the corrosive and destructive action of the gypseous rock and marsh waters; the most interesting cases combine the two advantages, thus getting the best out of these remarkable properties. These are, in principle, very different, but they have this in common that the compactness of the concrete is always favorable to them, especially when it is a question of reinforced masses.

The intrusion of the mineralized water in a concrete body, even when this is unalterable as in the case of aluminous cement, sets up internal deposits crystallizable by superhydration and expansion, or the collection of soluble limes, or a decrease in the mechanical resistances; it must therefore be avoided. If the useful work, demanded of the masonry, does not justify the considerable resistances of aluminous cement in the usual proportions, it is advisable not to practice thinning or shrinking without paying attention to the maintenance of the compactness; this end is attained either by carefully studying the mixtures of sand and gravel, or in replacing the pure cement by sand cement. The calculation of the resistance to crushing strain, according to Feret's formula, so well proved in practice

$$R = K \times (C/1 - S)^2$$

shows that, if the coefficient of resistance K of the cement only decreases in proportion to the amount of thinning in respect of pure clinker, the modulus of compactness contains in the square the term C of the absolute volume of bond, indicating the obvious advantage of sand cement over a meagre proportioning in pure cement.

These comparative estimations will enable us to put down pegs in this connection. The crushing of normal mortar cubes, beaten dry, proportioned in one weight of cement to three of normal Swiss sand, have given us the following results:

Resistances.	NORMAL MORTAR 1:3				
	1 day	2 days	3 days	7 days	28 days
1. Ordinary portland....	—	40 to 100	—	250 to 400	300 to 500 kg/cm 2
2. Special portland....	—	150 to 200	—	350 to 550	550 to 650 "
3. Pure Electro cement....	586	500 to 700	730	700 to 800	750 to 850 "
4. Mixed Electro cement (Sand Cement 50%)	331	—	407	440	— "

The resistance of the mixed cement (sand cement 50%) mortar has therefore usually attained 56% of that of the pure aluminous mortar.

Calculating the same price for sand and labor per metre cube of mortar, that is 29 francs, and adding that of 500 kg. of these various cements, at the price obtaining in Switzerland, where the aluminous cement costs about the double of portland, we obtain the following costs of the metre cube of finished mortar:

	Fr.
1. Ordinary portland cement mortar.....	66.50
2. Special portland cement mortar.....	76.50
3. Pure aluminous cement mortar.....	122.00
4. 50% sand cement mortar.....	89.00

The kilogramme of resistance of the concrete, in a metre high column, thus attains, in accordance with the types, and in thousandths of gold centimes, the following prices:

	PRICE OF THE KILOGRAMME OF RESISTANCE IN MORTAR				
	1 day old	2 days old	3 days old	7 days old	28 days old
1. Ordinary portland....	—	16.60 to 6.65	—	2.66 to 1.66	2.22 to 1.33
2. Special portland....	—	5.09 to 3.81	—	2.18 to 1.39	1.39 to 1.18
3. Pure aluminous....	2.08	2.44 to 1.75	1.67	1.75 to 1.53	1.63 to 1.44
4. 50% mixed aluminous	2.69	—	2.18	2.02	—

The economic valuation of the types 2 and 3, special portland and aluminous cement, follows at once from the second table; from the yard point of view and at the price we pay the aluminous cement is advantageous when one has to "uncoffer" and put into service in the course of the week which follows the concreting; after this time and up to the fifteenth day, the use of the special high resistance portland cement is called for (Innsbruck rules). Later, the margin of the resistances, due to the increasing hardening, allows of one contenting oneself, in the more usual types of constructional work, with the ordinary artificial portlands, corresponding with the established requirements. More attractive prices for aluminous cement, such as is permitted by large production, would naturally extend its commercial use outside the limits sketched above.

The aluminous sand cement, No. 4 in the tables, plays a separate role, in the sense that the speed with which it hardens is not essentially different from that of the pure cement. The price of its normal mortar is, according to the preceding estimation, 73% of that of pure cement, whilst its resistance falls to 56% only; these two falls parallel and unequal result in one obtaining, at the price of the kilo of resistance calculated in pure cement, only 56/73 kilo when the mixed cement is in question; therefore $1/0.73 = 1.37$ times as much mixed cement is used. The minimum proportioning for the mortar being fixed on grounds of compactness, the resistance attained will exceed the end prescribed, if the pure cement is used; it will then be advantageous to use the mixed cement mentioned above even stretching the proportioning, if the resistance required does not exceed 56/73, that is to say 75% of that authorized by pure cement. As a proportion 1.37 times greater will then be used, compactness will have greatly gained, and the resistance will be greatly increased, without the calculation above taking it into account. One may try to explain this obvious advantage of the mixed cement, which ought to lead to its manufacture on the place where it is used after transport of the unground clinkers, partly by the fact that the powder, reputed to be inert, and which is not necessarily so, if it is feldspar, contains a reserve of dampness which readily absorbs the aluminous cement, once its preliminary drying is achieved.

We have reasoned here on the results obtained with mortars, we might of course, do the same with concretes, for all careful experimenters who look for the generalization of Feret's Law of Compactness, observe the justification of it in concretes as well as in mortars; Professor Schuele, for example.

The only objection that can be made in this respect seems to be that the conditions of conservation of the normal mortar testers, the bath or the damp cupboard, are particularly favorable to aluminous cement, and that they cannot be transported right away to the concreting yard. Electro cement seems, in fact, to benefit more than portland cement from the hardening conditions in a damp environment which clearly favours its use in gallery and foundation work.

Resume—Electro aluminous cement appears to be indicated as most suitable in all cases where great mechanical resistance must be attained within about 72 hours, and where chemical stability must be complete in presence of sulfates, in general, and magnesium salts more particularly. The great mechanical resistance of the aluminous cement mortar is naturally much greater in respect of crushing than shearing strain; therefore there can be no question of looking to this resistance to traction for practically relieving the metallic armatures of the cambered concretes, calculated for conventional security on the stretching strain of the armature.

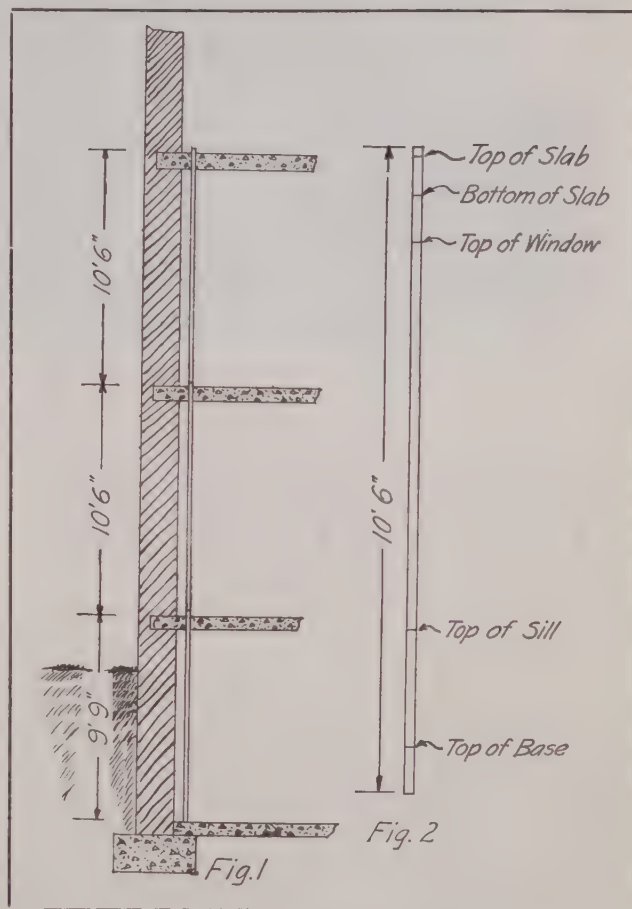
The resistance to crushing strain of the pure cement

mortar may be too great for the purpose intended. The use of sand cement will then be considered, which will be able to do the work more economically without interfering with compactness, an essential element of resistances. The question of sand cement is quite naturally introduced from the economic point of view in a country like ours where the basic materials, bauxite and coal have to be imported.

The Story-Pole

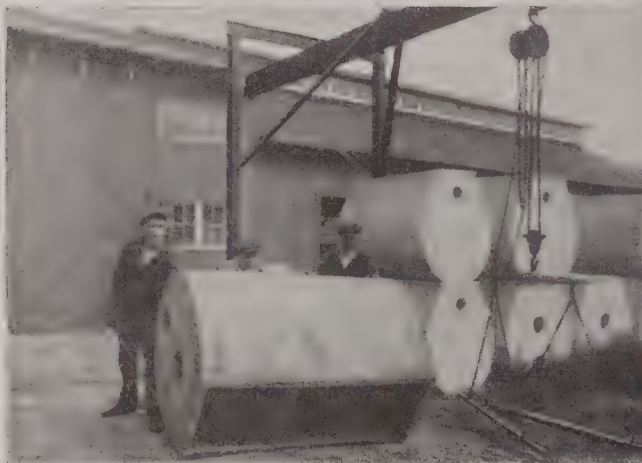
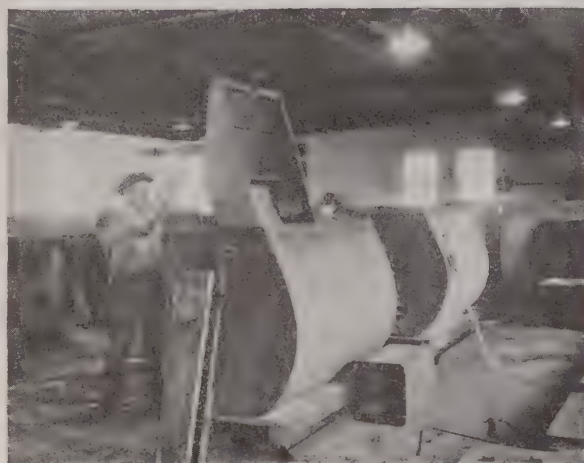
The illustration shows a reliable system for locating the various points for a reinforced concrete structure.

Fig. 1 shows a section, in part, of a three story building with a basement. Fig. 2 is a detail of the story-pole showing the various points that should be marked on it, such as, top of slab, bottom of slab, top of window, top of sill, top of base, etc. From these points any less important points can be obtained by adding to or subtracting from, whichever the case may demand. The story-pole should run through the slab



and project about 2 in. above, so that it can easily be located after the pouring is done. When the first slab has been cast and the forms for the second are being erected, the second story-pole should be set on top of the first one and nailed. For the next story simply repeat the operation.

Whenever any of the above mentioned points are needed, take the leveling instrument and transfer the point from the story-pole to the place where it is needed. With this system it is impossible to make any serious mistakes when locating the various points. Of course, the story-pole should be thoroughly tested out before using it. Place the pole where it will be convenient, and where it will not have to be removed until all the points have been established.



STEPS IN SEPTIC TANK MANUFACTURE AS TOLD IN MR. BROWN'S ARTICLE

Alumina Replaces Portland Cement in Septic Tanks

BY F. M. BROWN

PRESIDENT, AMERICAN SANITARY PRODUCTS CO., STAMFORD, CONN.

The introduction of high alumina cement in the United States by the Atlas Lumnite Co. has already brought forth some interesting results and from now on much will be heard of its use in all types of construction work.

Lumnite cement was brought to the attention of The American Sanitary Products Co., Stamford, Conn., which tried it out in the manufacture of septic tanks. The results of the tests made were so highly satisfactory that the company has decided to use nothing but Lumnite in its future work.

Where steel forms are used over and over again as is the case with these precast septic tanks, the time element is an important factor. Permanent forms tie up a lot of capital, and waiting two and three days for concrete to harden sufficiently to remove them, necessitates a quantity of forms, which during this hardening period, earn nothing on the investment. Lumnite cement solves this problem by speeding up production far beyond the dreams of the portland cement worker.

The American septic tank is made in one complete

casting and the average thickness of walls is 2 in. It is poured bottom side up and after it has hardened enough to stand the strain, is rolled over to its upright position and forms are then removed. With portland cement it has been necessary to allow tanks to stand in the forms from 48 to 72 hours before turning, the 48 hour period applying only in the warm summer months. Even with 72 hours of curing, great care must be taken in removing the forms so as not to strain the casting. Careless work may produce a minute crack which cannot be seen until the tank has dried out thoroughly, at which time patching is difficult and unsatisfactory.

To increase the strength of the tank and facilitate early handling, reinforcing in the form of a 2 in. mesh 16 gauge wire has been used, together with $\frac{1}{4}$ in. rods around the top of the tank and in addition to this, to both strengthen and water-proof, Cal has been added, 8 lbs. to the bag. This ingredient greatly accelerates hardening and has proved to be the best of some 8 or 10 different products tried.

In trying out Lumnite cement, two tanks were cast, one using the same amount of Lumnite as of portland and the other with two thirds the amount. Both of these tanks carried regular reinforcing. The pouring was completed at 12:30 noon and the following day at 8:00 a.m. these tanks were rolled over and forms removed. The tank with the leaner mixture was then filled with water and found to be practically water tight except for one or two places where insufficient ramming had left small voids. The surface of the concrete was so hard it could be scratched only with a sharp tool applied with considerable pressure. I men-

tion this because Lumnite has the property of hardening from the center of mass outward, and if this be true, the tanks were certainly hard all the way through. Of course no Cal was used in these tests.

No further tests were made on these tanks, but a third one was cast with full cement allowance, but no reinforcing. This tank was turned 18 hours after pouring and subjected first of all to the same water test and found water tight. The tank was allowed to stand all day in the shop and on the next day was taken into the yard and subjected to further tests.

The weak part of these tanks is naturally along the top edge, so the first test was to roll the tank over and over on ordinary ground, subjecting these top edges to the strain of supporting the whole weight of the tank, namely 1400 lbs. as it passed this edge. The tank was then righted and raised off the ground about 6 in. by a crane and a rope placed around the middle, and then rocked end wise so that each end in turn hit the ground with considerable force.

For a third test, the tank was set on the ground and one end raised about 6 in. and allowed to drop on a 2x4, thus putting a severe strain around the middle of the tank. A careful examination was then made to determine any fractures or damage and the tank was found to be in perfect condition. The results of all these tests on the non-reinforced tank proved conclusively the claims made for Lumnite cement.

Comparing costs of materials, we find that using the same amount of Lumnite cement as we have been using of portland, but eliminating reinforcing and Cal, we can manufacture our tanks at a saving of 84c in material and using two thirds quantity of Lumnite, at a saving of \$2.42. And more important than this, it has increased the capacity of our plant three times without a cent of outlay and at an actual saving in production costs.

Variations in Testing Methods

A wide variation in the methods employed in the testing of materials used in the construction of Federal-aid roads was found by F. H. Jackson and C. E. Proudley, testing engineers for the United States Public Roads in visits made during the last two construction seasons, for the purpose of ascertaining to what extent the laboratories were following approved methods in testing as recommended by the committee on tests and investigations of the American Association of State Highway Officials and approved by the Bureau of Public Roads. The observation made during these visits as recorded in *Public Roads*, issued by the United States Department of Agriculture, indicates that in the character and amount of space and equipment available, not less than 20% of the laboratories were totally unsatisfactory for their purpose, and only about 30% were in what might be termed first class condition. The factors taken into consideration were floor space, light, ventilation, convenience and kind of equipment, whether standard or otherwise, in good or bad repair, and whether it was adequate to meet the requirements of tests as specified.

Much may be done toward increasing efficiency in the laboratory by judiciously arranging the equipment. There is a limit to the amount of material which can be made to occupy a given space, and it is true of several laboratories that more careful planning might have greatly facilitated the work. Besides the incon-

venience of operating in crowded quarters, there is a decided disadvantage in not being able to inspect, clean, and repair machinery in the proper manner. With one exception, and that a small laboratory, it was observed that the congested equipment was in more or less poor condition.

The rock-testing equipment, it was found, usually received less care and attention than any other kind of apparatus. Sieves and screens came next, and last, but of equal importance, the water storage for cement mortar specimens was too often slighted. In many cases it was noted that certain details of the specifications of the American Society for Testing Materials for storage of cement specimens were not being followed. This applies particularly to the temperature of the clean water in the storage tanks.

Another obvious fault with the equipment of a number of laboratories was the lack of essential apparatus or the use of makeshifts of very doubtful efficiency. More thought for the welfare of laboratory operators, more careful arrangement of apparatus, and a wiser selection of equipment would undoubtedly increase the efficiency of the average road materials laboratory many times over.

Although all portland cement is supposed to be tested under the specifications of the American Society for Testing Materials, which have remained practically unchanged since 1916, more variations in methods were noted in testing this material than any other. They ranged all the way from distinct violations of specification requirements, caused either by inexperience or prejudice, to minor variations in technique due to the personal equation of the operator or to differences of opinion regarding the proper interpretation of the specifications. To sum up, it seemed to be a matter of general observation that whereas the methods of testing cement employed by the newer organizations were usually such as to yield results lower than normal, the work of most of the commercial and some of the older state and university laboratories would have, as a rule, the opposite effect. Taken as a whole, conditions would certainly justify a vigorous campaign of education among cement testing laboratories on the part of those interested and would seem to justify to a certain extent, the contention of the cement manufacturers that unreliable tests data are being turned out in some cases.

Variations from standard methods of testing concrete aggregates were not so common nor so serious as in the case of cement.

Not all laboratories visited were conducting tests of materials incorrectly. Most of the older state and university laboratories as well as some of the commercial laboratories were found entirely satisfactory insofar as actual methods of testing were concerned. The one outstanding exception to this rule was the matter of cement testing, which was found to be in a most unsatisfactory state. It is safe to say, however, that in the majority of the laboratories inspected, incorrect methods of testing of a more or less serious nature were being followed.

With regard to the general question of laboratory personnel, the writers take exception very strenuously to the belief that anyone can make routine tests. If there is one job in connection with highway work which requires preliminary training and experience, it is that of the routine operator in the testing laboratory.

This magazine is a forum for the exchange of ideas.

Graded Aggregate

Simplify Steel Reinforcing Bars

Because of a large number of varying specifications for steel reinforcing bars used in construction of roads, bridges, buildings and other structures, proposals for simplification of the varieties of this commodity will be considered at a meeting, September 9 in the Department of Commerce, announcement comes from the Division of Simplified Practice, under whose auspices the conference will be held.

Based upon an analysis of experience and sales demand, it has been suggested by representative dealers that the following sizes of steel reinforcing bars be used as a basis for a simplified practice recommendation:

Square: $\frac{1}{2}$ in., 1 in., $1\frac{1}{8}$ in., and $1\frac{1}{4}$ in.

Round: $\frac{3}{8}$ in., $\frac{1}{2}$ in., $\frac{5}{8}$ in., $\frac{3}{4}$ in., $\frac{7}{8}$ in. and 1 in.

Surveys reported to the Division show that many rolling mills, manufacturers, dealers and consuming interests have already adopted these sizes, which can be supplied economically by all producers. It is declared that the range in the recommended sizes would be sufficient to supplant the 15 sizes now used in each style.

Endorsement of the recommended sizes will be asked from Government departments and technical bodies, as well as architects, contractors, engineers, bridge and road builders as well as other consuming interests.

As to the flat-shaped bars, no suggestions have been made, but it is expected that existing conditions will be discussed and a survey may result.

Suggestions have been received by the Division that an "intermediate" grade, embodying the desirable features of "structural" and "high carbon" grades, would enable dealers to cut their stocks from 30 piles to half that number, or even to one-third if one grade were adopted. The question of a future course of action concerning an adequate and sufficient grade of steel will be referred to technical bodies concerned.

* * *

75% Productive

That building trades workers in the average American city are employed less than three-fourths of the time at their trade, is the finding of a committee appointed by Herbert Hoover, Secretary of Commerce, to survey the building situation in the United States with a view to determining why building construction could not continue through all seasons of the year. The report says men in the building trades must be paid enough to support themselves and their families for 12 months on wages received for 7 to 10 months' work; contractors have 12 months' overhead costs to charge against the jobs done during 7 or 8 months. Building supply dealers must maintain establishments big enough to handle a large amount of work during 4 or 5 months. Manufacturers have to maintain unnecessarily large plants and equipment or else stock up materials during dull season in order to meet peak demands. Architects find their office work crowded largely into the first 6 months of the year, although their field work is often active for some months later. Intermittent employment conditions keep young men from taking up the building trades, and account in large part for the high hourly wage rates, and give a false impression of actual earnings.

Improved Brick Tester

An apparatus for testing brick which is considered superior to existing equipment has been designed by the Bureau of Standards, Department of Commerce. The present standard apparatus, the Bureau points out, has many loose parts which fall on the floor or are scattered when the brick breaks, whereas in the case of the Bureau's apparatus all the parts stay in position.

The making of tests with this new apparatus was found to require only 58% of the time required with the old apparatus, an important saving when many brick are to be tested. Results obtained in tests were found to be in agreement with those obtained by tests on the old apparatus. Tests were made with the brick supported at the ends and loaded in the middle as in a beam, and clay, cement and sand-lime brick were used in the tests in order to make sure that the new apparatus gave correct values for the strength of any of the bricks which are commonly used in buildings. This apparatus is described in Technologic Paper No. 257 of the Bureau of Standards, copies of which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents.

* * *

F. W. Ives New A. S. A. E. President

Frederick W. Ives, head of the department of agricultural engineering at Ohio State University, has been elected president of the American Society of Agricultural Engineers to succeed S. H. McCrory of the U. S. Department of Agriculture. In addition to the position he holds at Ohio State University, Professor Ives has an outside practice as consulting agricultural engineer and architect; he is one of the outstanding authorities on farm building design and practice in the United States. He was elected to membership in the Society in 1916 and has been one of its most active and enthusiastic workers since that time, having served as secretary-treasurer, member of the Council, and as chairman and member of a number of important committees, principally those pertaining to farm structures and agricultural-engineering education. During 1923 he was the Society's alternate representative on American Engineering Council. Other officers elected are H. B. Walker, professor of agricultural engineering, Kansas State Agricultural College, first vice president; W. A. Foster, professor of agricultural engineering, University of Georgia, second vice president; R. W. Trullinger, specialist in rural engineering, Office of Experiment Stations, U. S. Department of Agriculture, elective member of the Council. Raymond Olney was reelected treasurer.

* * *

Silicate of Soda in Block Molds

Concrete blocks formed in steel molds, although they are very useful, rarely make the artistic appeal which is produced by natural stone. A convenient method suggested for overcoming this defect is to apply a viscous soluble silicate to the inside of the mold. This acts as an adhesive for a layer of round pebbles which are next applied and firmly held in place by the silicate which does not, however, cover much of the surface of any individual pebble. When the wet concrete is poured in, it flows around the pebbles and grips them firmly, at the same time wetting the silicate and to a limited extent reacting with it. The blocks come out of the mold nicely and any residual silicate is easily washed away.

Waterproofing of Gypsum Blocks

Cylinders of neat gypsum and sanded gypsum treated with various waterproofing materials and exposed to the weather for from 2 to 3 years have been tested by the Bureau of Standards for loss or gain in weight and absorption. Cylinders of neat gypsum and those treated with barium hydroxide exposed to the weather for 6 months have been tested for the same properties together with compressive strength. Cylinders treated with barium hydroxide show considerably less erosion than those of neat gypsum. They appear much harder, have gained considerably in weight, and decreased in absorption, but the compressive strength has fallen off.

* * *

Billion Increase In Farm Wealth

Estimated gains in farm wealth through rising prices of farm products are a billion dollars. Such gains are usually a benefit to the country generally, and what is of such general benefit is promptly reflected in construction.

* * *

Upham Heads Highway Research

Charles M. Upham, State Highway Engineer of North Carolina, has been appointed director of the Advisory Board on Highway Research of the National Research Council, to succeed Dr. W. K. Hatt, who resigned in order to resume his work at Purdue University. Mr. Upham received his early training with the Massachusetts Highway Department and later became chief engineer of the Coleman du Pont road. For four years he was chief engineer of the Delaware State Highway Department when he was called to take charge of the extensive highway construction program in North Carolina.

* * *

Motor Transportation Show

The first National Motor Transportation show will be held in Chicago, October 21 to 27, at the American Exposition Palace on Lake Shore Drive, a building recently completed at a cost of \$10,000,000. The show is to be held under the auspices of the Motor Truck Industries, Inc., an association which represents the leading truck manufacturers of the country. A program of demonstration is to be held daily in a large field adjoining the exposition building. William Hallanger, general manager of Motor Truck Industries, is planning the demonstration program.

* * *

Cinder Block Again Show Up Favorably

The general public doesn't thoroughly comprehend a scientific fire test of the laboratory variety but it does swarm to see and is quick to applaud those open lot tests that are becoming so popular in demonstrating the fire resistance of concrete building block.

There was such a test at Reading, Pa., July 12, as a demonstration of locally made Straub cinder block. Shrewdly enough it was a comparative test with competing products. Something of what happened is told in a letter by Richard Neff, chief engineer of the Bureau of Building Inspection, Pittsburgh:

I attended the fire test made at Reading, Pa., July 12. The building was 12 x 20 x 11 ft. high with a wood roof. The outer walls were constructed of cinder block, clay brick and hollow clay tile. The front of the building with openings for firing was entirely of cinder block. There were three compartments. One of the partition walls was entirely of Straub block and on top of this wall was placed ten tons of pig iron. The other compartment wall was composed of cinder block, hollow clay tile and clay brick. There was no weight placed on top of this partition. All walls were eight inches in thickness.

I examined the exterior and interior walls before the fire and found the workmanship to be good and the material arranged in a manner

indicating every intention that the test might be fair to all materials used.

After the fire had been quenched at the end of one hour, I again examined the walls and found that 99% of the clay tile were cracked and certainly looked as if they were not re-usable. At least 50% of the brick were destroyed for further use. The Straub block were practically uninjured, so far as re-use was concerned.

This is not the first fire test that I have seen in which Straub blocks were exposed to even greater heat and, therefore, I was fully prepared to see these results. For more than four years I have been convinced that Straub block are paramount in fireproof qualities compared with any other known building material, but it was not until after I was convinced of their other structural qualities that their use was permitted in the city of Pittsburgh and this material made in accordance with the Straub process I fully recommend for durability, safety and economical construction.

* * *

Cinder Block Patent Suit

Crozier-Straub, Inc., owner of Straub patent No. 1,212,840 for cinder building block, filed suit in the District Court of the United States for the Western District of New York, at Buffalo, July 7, 1924, against the Genesee Brick & Supply Co., operating under a Bo process patent. The suit is based upon the Straub patent which the Genesee company is charged to have infringed by the manufacture and sale of cinder building block. The Crozier-Straub company in its complaint prays for an injunction restraining violation of its rights under its patent and for an accounting of profits made by the defendant and damages sustained by the plaintiff by reason of the manufacture and sale of building block embodying the invention of the patent sued upon.

Resurfacing Granolithic Floors

BY G. W. MAKER

Granolithic floors, composed of suitable materials properly proportioned and carefully laid, should last indefinitely under average conditions of wear, and under the most severe conditions should give longer service than any other type of floor surface.

In many cases, however, the difference between average workmanship required by structural concrete and the skillful attention required in the selection of materials, proportioning of mixture and placing of granolithic finish, is not recognized, with the result that a floor often turns out poorly, does not give the service it should, and in some instances has to be relaid.

One interesting case of a poor floor developed recently, where the Aberthaw Co., of Boston, was given the contract to resurface about 3400 sq. ft. of concrete floor in a small manufacturing building in New Britain, Connecticut. Although the building was only about seven years old, the granolithic surfaces had already been patched in places, and were in such condition as to make complete renewal necessary. This work offered an excellent opportunity for studying the reasons for failure and for getting accurate costs on the work of renewal.

It was originally intended to remove the old finish with compressed air tools, using the factory air supply; this supply, however, was found to be inadequate and, as conditions developed, air tools were not necessary.

There was practically no bond between the surface course and the structural slab. The top came up very easily, using ordinary construction picks. The ease of removal is best indicated by the fact that practically the whole area came up in large pieces, some of these having an area of 1 sq. ft. or more. Six men removed nearly 3000 sq. ft. in one day.

The original finish varied in thickness from $\frac{3}{4}$ in. to $1\frac{1}{2}$ in. Its appearance indicated a mixture of sand, stone dust, and cement, more in the nature of plaster than concrete; in fact, the lack of weight was particularly noticeable, and the large pieces, when dropped, would break up completely.

In some areas, there appeared to have been considerable laitence, while other places showed an attempt to clean the slab before the finish had been applied. Where laitence was found, part of it came up with the finish, and part of it adhered to the slab.

After all the old finish had been removed, the floor was swept thoroughly clean with wire push brooms, followed by ordinary stiff stable brooms. This sweeping showed up any areas where laitence remained. The entire area was then gone over once more, this time with picks reversed. The floor was then swept again, first with wire and then with stable brooms. Following this second sweeping, the whole floor was thoroughly soaked, and the water allowed to stand on it over night. The slab appeared to take up a considerable amount of water. The next morning, all places where there were still traces of laitence, were

gone over once more with picks, and the whole floor once more swept and soaked with water, and kept wet approximately 36 hours before the new top surface was applied.

The new finish was mixed in the proportion of one part cement, one-half part sand, and one and one-half parts of $\frac{1}{2}$ -in. crushed trap rock, which is the Aberthaw standard specification for granolithic. Somewhat more than the usual amount of water was used in mixing, the idea being that the slab would continue to take up moisture. The amount of water, however, was not sufficient to give a mixture so wet that the fine particles would come to the top.

The slab was thoroughly wet for some 10 ft. ahead of the new finish. Dry cement was worked into this wet surface with brooms, and the new finish applied to that area before the thin coating of cement reached its initial set. The finish was levelled by means of screed strips in the usual way, and finished with the ordinary wood floats and steel trowels.

An inspection of the new surface the day following its application showed that the edges along the walls were apparently drying out faster than the rest of the floor. These areas were accordingly wet down, and then the whole floor covered with clean burlap bags which were thoroughly saturated with water and kept wet for ten days. At the end of this period, the floor was turned over for factory use.

The total cost of this work was just over \$1000, or approximately 30¢ per sq. ft. These figures included labor, materials, and miscellaneous expenses as well as contractor's profit. The direct labor cost was approximately 15¢ per sq. ft.

While this labor cost does not compare with the usual figure of $4\frac{1}{2}$ ¢ to 5¢ for finish in a new building operation, it will be understood that the greater part was expended in the preparation of the structural slab to insure bonding on which the success of the work depended.

Rolling Mild Carbon Steel

The finishing temperature and total reduction are the most important factors affecting the properties of rolled plate made from mild carbon steel. Initial temperature of rolling, pass reduction and roll speed have no appreciable influence according to results obtained by the Bureau of Standards, Department of Commerce, in the completely equipped experimental plant of its

Metallurgical Division. It was also shown that when steel is rolled in one direction only, which is often done as a matter of convenience in obtaining the desired shape, the mechanical properties in the direction at right angles to that of rolling are inferior to those in the direction of rolling.

Since the greater part of all steel manufactured is subjected to mechanical work by hot rolling, forging or drawing, the importance of this investigation is obvious. This working of metal serves a two-fold purpose. In the first place it gives the metal the desired form, such as bars, plates, structural shapes, rails, etc., and in the second place it breaks up the coarse, weak, crystalline structure of the cast ingot replacing it with a finer grained structure which greatly improves the mechanical properties of the steel.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 1807 East Grand Boulevard, Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Commission; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth Street, New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Rudolph P. Miller, President, Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

The National Concrete Stave Silo Association; W. G. Kaiser, Secretary, 111 West Washington St., Chicago.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East 22nd St., N. Y. C.

The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; T. R. Borrows, Acting Secretary, 903 Munsey Bldg., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington Street, Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.